THE

ELECTRICAL REVIEW.

VOL. LIV. APRIL 15, 1904. No. 1,377.

ELECTRICAL REVIEW.

Vol. LIV.] CONTENTS: April 15, 1904. [No. 1,377.

	Page
Blondlot's N-rays	609
Distorted Alternating and Rotating Magnetic Fields (*illus.*) (*concluded*)	611
The Ionisation of Air (*illus.*)	612
A Criticism of Mr. James Swinburne's "Entropy"	613
Correspondence	615
Reviews	616
Marine Turbine Steamers	618
Our Legal Query Column	619
The Action of Radiant Heat	619
Business Notes	619
Liverpool—Southport and Crossens Electric Railway (*illus.*) (*concluded*)	627
Aston Manor Electricity Works (*illus.*)	630
Electricity Supply Accounts	634
City Notes	635
Stocks and Shares	638
Share List of Electrical Companies	639
Market Quotations	640
Electric Tramway and Railway Traffic Returns	640
Institution of Electrical Engineers.—Localisation of Faults on Low-Tension Networks (*illus.*) (*concluded*)	641
Small Gas Engines *v.* Electric Motors	644
The Report of the Mosely Educational Commission	644
The Right to Oppose a Tramway Bill	646
Some Details of the Westinghouse Single-Phase Railway System	647
Chain Grate Stokers	647
Dispersion and Wave Length of N-rays	648
New Patents Applied For	648

THE

UNIVERSAL ELECTRICAL DIRECTORY

1904 Edition

Price, in Great Britain, 10s. Post Free.

BRITISH COLONIES, 12s. Post Free.
U.S.A., 15s., Carriage and Duty Free.
OTHER COUNTRIES, 13s. Post Free.

H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.
Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades, AND HAS

BY FAR THE LARGEST CIRCULATION
of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s 6d. each; post free 2s. 9d.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street, Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co, 13, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr H. ALABASTER, 4, Ludgate Hill, E.C.

BLONDLOT'S N-RAYS.

So many different kinds of rays have recently been thrust upon us, that we naturally begin to resent any further addition to their number. The latest addition is the N radiation discovered by M. Blondlot, and this appears, if we are to accept the results of the experiments of their discoverer and his disciples, to have perhaps the most wonderful properties of all the remarkable kinds of radiation hitherto discovered.

According to these experiments, the N-rays are to be found in abundance in sunlight, they are copiously emitted by the Nernst lamp, and by the incandescent gas burner. These statements we might willingly accept, but when we are told that they are emitted by any body under strain, such as a bent piece of glass, tempered steel, Prince Rupert's drops, a strained muscle, and even by the brain when a man is thinking hard, we hesitate to believe until at least the experiments have been confirmed by independent observers. It appears, however, that no observer outside France has, as yet, been able to repeat M. Blondlot's experiments.

M. Blondlot uses several devices for detecting the presence of the N-rays. For example, a short electric spark passing between two platinum points is increased in brightness when the N-rays are allowed to impinge upon it. The light from this spark may be used to impress a photographic plate, and photographs produced in this way may be seen in an article by M. Marcel Ascoli in the *Revue Générale des Sciences*, March 15th, 1904. These photographs show that the impression produced by a spark exposed to the N-rays is distinctly greater than that produced by a spark not so exposed, and the result is difficult to explain away if other things are equal. Another device employed to detect the N-rays is a screen of phosphorescent sulphide of calcium. These screens are said to become visibly more luminescent when exposed to the N-rays in a dark room. It is admitted, however, that many precautions are necessary before this effect can be seen. An eye not accustomed to the obscurity, or fatigued, or most frequently in making a great effort to see the screen, will observe variations of luminescence which are purely subjective. All these sources of error, as well as the variations of luminescence due to change of temperature, are said to have been eliminated by M. Blondlot. He has also measured the refractive indices of the rays by passing them through an aluminium prism, as described on p. 648 in this issue. The wave lengths have also been measured, and from these measurements the position of the N-rays in the spectrum appears to be above the ultra-violet rays.

The transparency of substances to the N-rays varies very considerably. Pure water is perfectly opaque, but when salt is dissolved in the water, it becomes almost perfectly transparent. N-rays traverse with very little loss, wood, paper, quartz, rock salt, glass, and aluminium. They are

stored up and again given out by quartz, fluorspar, glass, barytes, and many metals. The sulphide of calcium used as a detector on screens also stores up the rays, and this property has the effect of retarding the changes of luminescence observed upon the screen.

A serious attack on the validity of M. Blondlot's experiments is made by Mr. Schenck, of McGill University, in *Nature*, March 24th. He failed after taking every precaution stated by M. Blondlot to verify his experimental results. He also demonstrated by calculation that the aluminium prism used by M. Blondlot to refract the N-rays could not have produced any real separation between the different kinds of rays, and, consequently, that it would have been impossible to measure the refractive indices and the wave lengths. Mr. Schenck considers that many of the changes of brightness observed on the sulphide of calcium screen by Blondlot and his followers, were really due to variations of temperature.

Evidently the scientific world must suspend judgement on this question of the N-rays until the experiments can be repeated without difficulty by any skilled observer who complies with the specified conditions. The existence of radiations from the brain and other nerve centres of the human body has long been a favourite hypothesis with the believers in thought transference, but we fear it has still to be demonstrated as an unquestioned scientific fact.

Gas Engines *v.* Electric Motors.

In our issue of the 18th ult., we gave an abstract of a paper on "The Distribution of Electricity in Shipyards and Engine Works," by Mr. J. A. Anderson, in which particulars were given of a shipyard shed which had formerly been driven by a gas engine of 50 N.H.P., but the substitution of electric motors for driving the various machines had resulted in a reduction of about £50 in the running cost in five months. However, in this comparison the gas used was retort gas, costing 2s. 6d. per 1,000 cb. ft. Had the gas engine been run on producer gas, or blast furnace gas, costing not more than ½d. per 1,000 cb. ft., the comparison would have assumed a very different aspect. The employment of retort gas having a thermal value per cb. ft. of 600 B.Th.U. does not result in a higher thermal efficiency than with gas of only 140 B.Th.U. per cb. ft., so that the equivalent of the 1,380,500 cb. ft. of retort gas would be 5,916,429 cb. ft. of producer gas, which, at ½d. per 1,000 cb. ft., would cost £12 6s. 6d. Allowing the figures given for attendance, water, oil, and stores to stand as given for retort gas, at £57 11s., the total for the five months would be £69 17s. 6d., as against the cost of electric current for motors during a similar period, as given, at 1 1/16d. per unit, £145 14s. The economy in favour of the employment of producer gas and gas engines, over electric motors for the period given, amounts to £75 16s. 6d.; or per annum about £181 19s. This comparison is worthy of careful consideration, as showing that for certain applications the gas engine is very considerably more economical than electric motors, for the cost of current taken as a basis could only be reduced by the installation of an electric power plant on an economical fuel, and with a fair load factor, on the users' premises. In the neighbourhood of blast furnaces, the employment of that furnace gas would be both economical to the power user and profitable to the furnaces, as the price paid for the gas would be all profit after allowing for the slight cost necessary for rendering the gas free from dust, if it was not otherwise being turned into use.

Municipal Muddling.

So Darlington is still in the wood; of that there can scarcely be any doubt, for the chairman of the Tramways Committee unfolded a tale of woe to the Corporation last week. The sequence of events is easily told; a well-known tramway company, successfully operating in the neighbouring towns of Middlesbrough and Stockton, offered to provide a suitable system of tramways for the borough, and owing to its freedom in financial matters, could, no doubt, have very successfully done so.

The Corporation at first accepted this offer, but doubtless egged on by that section of its members which holds the branding of an undertaking with the word "Municipal" as a sufficient justification for its existence, this business-like body decided to buy out the tramway company, paying an item of £7,500 for the privilege of changing its mind. Construction of the tramways then proceeded; incidentally, a gauge 1 in. less than that adopted by the neighbouring company was chosen, a step for which it will puzzle anyone not suffering from the Darlington complaint, to find justification.

After passing through the vicissitudes of innumerable constructional delays and two disappointments in that event most dear to the civic mind—the opening day, Darlingtonians are now called upon by their Tramways chairman to fortify themselves against an indefinite delay in opening, and, in plain English, when the line is opened, not to expect it to work without considerable loss to the ratepayer for some time to come.

Such are the joys of indiscriminate municipal trading, which, as matters stand at present, may lead us into a financial muddle, the extent of which will only be truly appreciated in after years.

The chairman's figures are an object-lesson to those who may be suffering from the Darlington malady, and they do not by any means convey the full meaning of the situation to the ratepayer. In fact, what he omitted to say is, in many responsible quarters, regarded as the most serious phase of the question. The municipalising tendency and its heavy calls on the Money Market are not sufficiently realised by the average ratepayer, notwithstanding the endless municipal loan advertisements which decorate the daily press and clearly emphasise the difficulties which at present characterise such borrowing.

In one issue of a Northern daily we have lately counted 18 such advertising municipalities, and that is precisely the position of Darlington, whose tramway expenditure has been met by a short loan, and whose future borrowings, in the event of any unforeseen occurrence, may result in considerably increased financial charges.

The Specific Heat of Superheated Steam.

With the assistance of a grant of £150 from the Manchester Steam Users' Association, Dr. Husker and Mr. Jakeman have been conducting experiments at the National Physical Laboratory upon the specific heat of superheated steam or steam gas. At and near the saturation temperature, steam has a specific heat of 0·480, or thereabouts. At high temperatures the coefficient is known to be much higher. Various experimenters have shown figures for the specific heat of various gases at high temperatures which are several times that at so-called normal temperature. Berthelot has proved that the calorific effect of hydrogen falls off most seriously at high temperatures. This may not be due altogether to the raising of the specific heat. Part of the effect may be due to actual dissociation, and it is probably not possible to draw any sharply defined line of demarcation between one phenomenon and another. At all present practicable temperatures of superheat, it may be fairly accepted, however, that the increase of specific heat is the cause of reduced apparent calorific capacity. We say apparent because the lower observed temperatures do not, of course, indicate a less amount of heat. They do but indicate a greater heat-containing power per degree of temperature change.

Very little is known about superheated steam, if we are to judge by some of the claims put forward on its behalf. It is freely claimed by some that it owes its virtue to the fact of temperature, on the ground that superheated steam is working between a wider range of temperature than if it were saturated only. Saturated steam in production from ordinary feed water absorbs about 1,100 B.Th.U. in temperature and latent heat. The same steam superheated through a further 220° F. only absorbs about 110° B.Th.U., or, approximately, 10 per cent. of the heat of formation of saturated steam. Yet this 10 per cent. is called on to prevent the condensation in the cylinder, due to cooling of that cylinder, of from 20 to 40 per cent. of the whole steam.

This duty is usually quite sufficient for the few units of superheat, without a claim being made for any thermo-dynamic effect. Indeed, the poverty of the thermo-dynamic theory is made very obvious to anyone who will think out the inter-actions that occur in a cylinder and boiler combination while the piston is moving from the dead-point to the point of cut-off. As the steam in the cylinder is not expanding, it cannot possibly be doing work, for steam cannot work except by virtue of change of volume. The work being done can, therefore, only come from the boiler, in which, if for convenience we assume a steady pressure to be maintained, the work done on the piston must come directly out of the furnace. But however it comes, such work is from the boiler, and the temperature of the boiler is the upper limit of the range between which the working fluid does work. The presence of a superheater between boiler and engine is a mere accident as regards the steam. True, the steam is made a vehicle of a given amount of surplus heat, merely, however, that the cylinder may be warmed and dried. This surplus heat, as stated above, may vary from nothing up to 10 per cent. or even more, of the total heat in the steam. Just how much the amount is, the experiments at Bushy House, Teddington, are intended better to elucidate. If a fair curve be drawn through some of Berthelot's values for the specific heat of steam at very high temperatures, and the value 0·480, according to Regnault, of atmospheric steam, this curve will probably pass through points not far removed from the correct value of the specific heat at such temperatures of superheat as occur in practice. Values of 0·55 to 0·60, or it may be even 0·65, are by some anticipated as likely to be found, and it is desirable that they should be authenticated. Superheating is considered in a very casual manner, and most of those interested in it do not take into their calculations its heat values or trouble themselves in the least as to the heat in thermal units that will pass through a given surface under a given head of temperature. Without this knowledge, and without knowledge of the effect of temperature on steel pipes or of the loss of efficiency due to taking care of such pipes by keeping their area small, so as to increase the flow velocity at the expense of pressure, the value of superheat cannot be determined. At Bushy House the heat absorbed by a given weight of steam, which is subsequently condensed and weighed, is measured electrically. Steam is generated in a large boiler and passed into a pipe in which a resistance is placed, made up of nickel steel tape. About 80 lbs. of steam per hour can be sent through the apparatus, and the steam is heated to 165° C. as a rule, or to a maximum of 300° C. It is to be hoped that the experiments will be carried on to at least 400° C., or even higher, in order to discern the effect of dissociation. If dissociation of a complete order does supervene towards the temperature of red hot iron, the products will not all condense, and may be collected after condensation as gas. The system of electric heating is peculiarly adapted to such an experiment, and we look forward with interest to the publication of the results.

DISTORTED ALTERNATING AND ROTATING MAGNETIC FIELDS.

By R. GOLDSCHMIDT.

(*Concluded from page* 572.)

It is of special interest to consider the two limiting cases :—

(A) Sine wave voltage, and
(D) Sine wave current.

From curves A and D it appears that with an effective voltage of 100 in each case the current in case A is 100 amperes, whilst in case D it is 20 amperes. In other words, if,

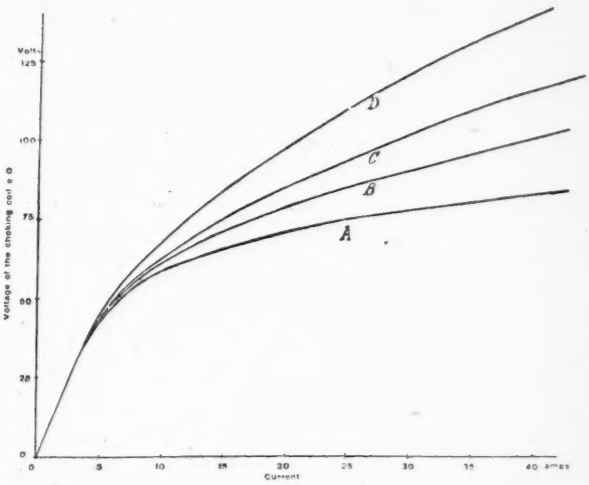


Fig. 7.—Four Magnetising Curves Obtained from the same Choking Coil with Different Values of R.

besides the saturated choking coil D, the circuit also contains a considerable reactance R, the current in the choking coil will only reach one-fifth of the value reached when R = 0, the voltage at the terminals of the choking coil being 100 in each case. With sine wave voltage (A) the current takes on

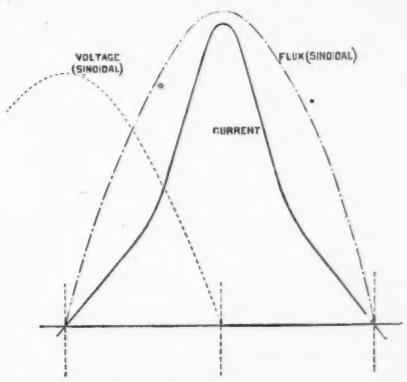


Fig. 8.—Case A (R = 0).

the well-known pointed form (fig. 8), and with sine wave current (D) the choking coil voltage has a pointed curve with high effective value (fig. 9).

As an amplification of fig. 8, a small table is given below, showing the effect of the added self-induction on the magnetising current at various voltages :—

Volts.	Magnetising current.			
	A	B	C	D
60	7	6·7	6 4	6
70	18	14	12 8	10 5
85	42	24	18 5	15
100	100	38	28	20

D

When making tests for magnetising current or hysteresis loss, as soon as the knee of the magnetisation curve is passed (*e.g.*, when measuring the losses in, and the magnetic resistance of, armature teeth, &c.) as large a generator as possible should be employed, as otherwise the voltage drop

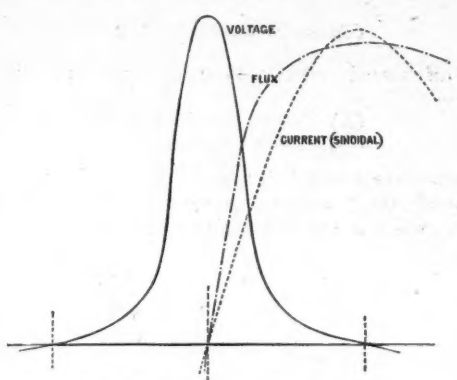
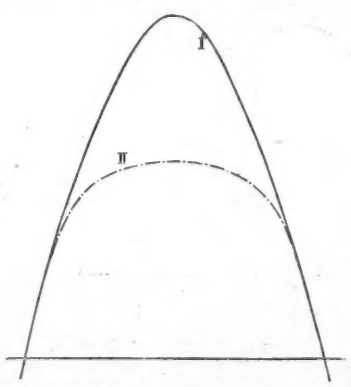


FIG. 9.—CASE D (R VERY LARGE).

will introduce errors both in the hysteresis losses and the magnetising currents measured. Also voltage regulation by the insertion of inductive resistances should be avoided at all costs. Even non-inductive resistances, if of considerable amount, may lead to noticeable errors.

In the case of unloaded induction motors, such simple curves as in figs. 8 and 9 cannot be obtained, first, because there is no longer any direct connection between the flux and the current, since a rotating field cannot be produced by a single alternating current, but depends on the currents of the different phases in the case of multiphase motors, and on the stator and the rotor currents in single-phase motors. Secondly, in figs. 8 and 9 the time forms the abscissa. It is, of course, possible to plot the current and the voltage of a rotating field motor as functions of the time, but this cannot be done for the field itself. The latter is of constant amount, independent of the time, and can only be represented by a space curve. It is also only this space curve which is distorted by saturation.

The form and amount of the field of an induction motor depend to a certain extent on the number of phases and slots, but we will assume that our motor, so long as saturation is absent, has a perfectly constant field of sine form with as many poles as the winding itself. We know, from the



I. Field curve of unsaturated induction motor; II. Field curve of induction motor with saturated teeth.

FIG. 10.

numerous investigations on the subject which have been published, that this assumption is very closely adhered to in practice with modern motors having numerous slots. We must, however, omit single-phase motors from this assumption, as in them the field is known to be elliptical, *i.e.*, a rotating field whose amount varies periodically with its position. In good single-phase motors these variations are not large, but they can never disappear entirely.

Curve I., in fig. 10, may be taken to represent such a sinusoidal field curve for an unsaturated motor. If, with the same magnetomotive force, tooth saturation is present, it will only become evident at the points of highest field density. At these points the flux density will be reduced and the curve will take the form shown in II., fig. 10. The tooth saturation, in fact, has a flattening effect.

This field may have superposed fields of higher frequency, *i.e.*, of a higher number of poles. Our assumption, however, that a six-pole winding in an unsaturated motor produces an exactly sinusoidal six-pole field is equivalent to the condition that only a six-pole sinusoidal field can induce a voltage in the winding. If, for instance, a $3 \times 6 = 18$ pole field were able to act inductively on the winding, *i.e.*, to become looped in some inductive way with the winding, the winding would also necessarily be able to induce an 18-pole field. This, however, would contradict our original assumption.* On this account deformation of the field cannot show itself in the voltage, so that the flattened curve II., fig. 10, will still induce a sinusoidal counter E.M.F. wave. With a terminal voltage of sine form a current of sine form will result, *i.e.*, in the case of induction motors, with many slots and having saturated iron, the current and voltage curves retain their sinusoidal form in spite of deformation of the field through saturation.

THE IONISATION OF AIR.

BY JOHN DON, B.Sc.

IN continuation of the experiments recorded in the ELECTRICAL REVIEW of March 5th, daily observations have been made with both positive and negative charges. While, for the first few days, two separate instruments were employed, the records were subsequently taken from the same instrument, charged alternately positively and negatively, in order to secure a more accurate comparison between the effects of the air upon the different electrifications. In general the results obtained with negative E confirm the deductions of the previous month, and in particular it was noted that easterly winds brought about only a very moderate fall of the leaves. Remarkable indeed was it that on February 9th, with an easterly gale and a very heavy, breaking sea, the passage of one third of a cb. ft. of air over the charged leaves gave rise to no perceptible collapse. On that day the electronscope showed the very curious phenomenon that a regular leak of about $\frac{1}{75}$ mm. went on for some hours when *no* air was being drawn. This happened both before and after the hour in which the actual experiment was made, when, as has been said, one third of a cb. ft. of air was carried past the leaves. On several subsequent occasions exactly similar appearances were observed, the leaves falling less when air was being drawn than when the air inside was left stationary.

In order to exhibit the records in a more intelligible form, a curve has been plotted (fig. 1), showing the fall of the leaves in $\frac{1}{25}$ mm. per $\frac{1}{10}$ cb. ft. of air drawn. In fig. 2 the same curve has been plotted after deducting the leak found when no air was being drawn, and it will be noticed that on February 9th, and again on March 3rd, the graph falls below the abscissa, thus indicating that the passage of the ionised air counterbalanced the leak, and operated so as to cause the leaves to *diverge*.

Side by side with the curve for negative E will be seen the corresponding record for the positive charge. With westerly winds the fall was usually moderate and occasionally quite insignificant, while winds from the sea as a rule were accompanied by a more or less rapid fall. A storm of wind from the south with a heavy sea was the cause of by far the largest loss of electrification as yet observed, amounting to $\frac{4}{25}$ mm. per $\frac{1}{10}$ cb. ft., and on that day there was no appreciable leak with the positive charge, and but very slight with the negative. On four days no loss of positive charge was perceptible when air was drawn through, and on three of these the wind was distinctly off the land. On the fourth the wind was a seabreeze, accompanied

* See the complete investigation by the writer in the *Electrotechnische Zeitschrift* for 1901. No. 16.

with showers of sleet and snow. The phenomenon referred to above in the case of a negative charge, was repeated several times with the positive electrification; for the leak when the air within the instrument was stationary, was on five occasions greater than the fall when air was drawn through. The graphic record clearly points to these interesting facts at the places where it crosses the abscissa.

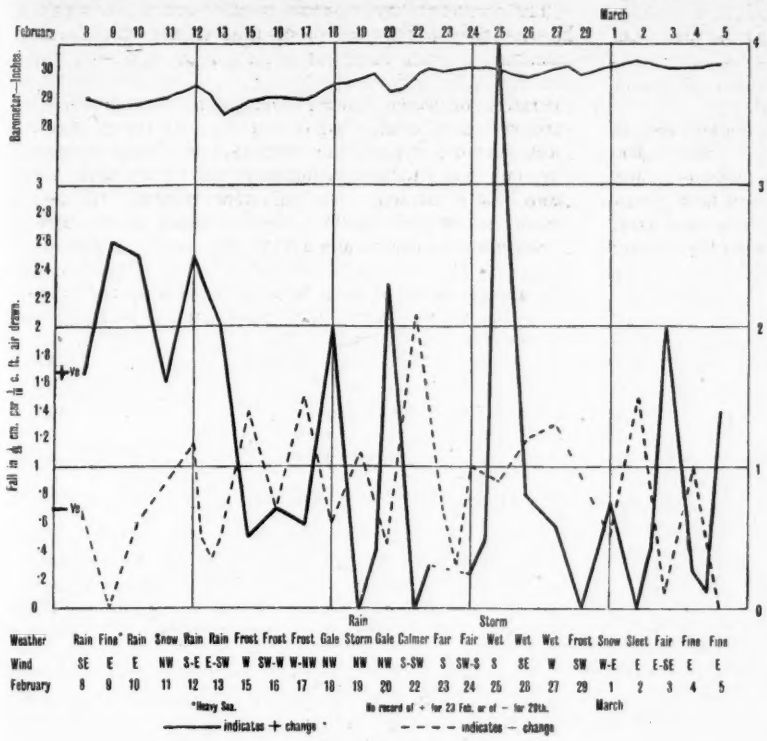


FIG. 1.

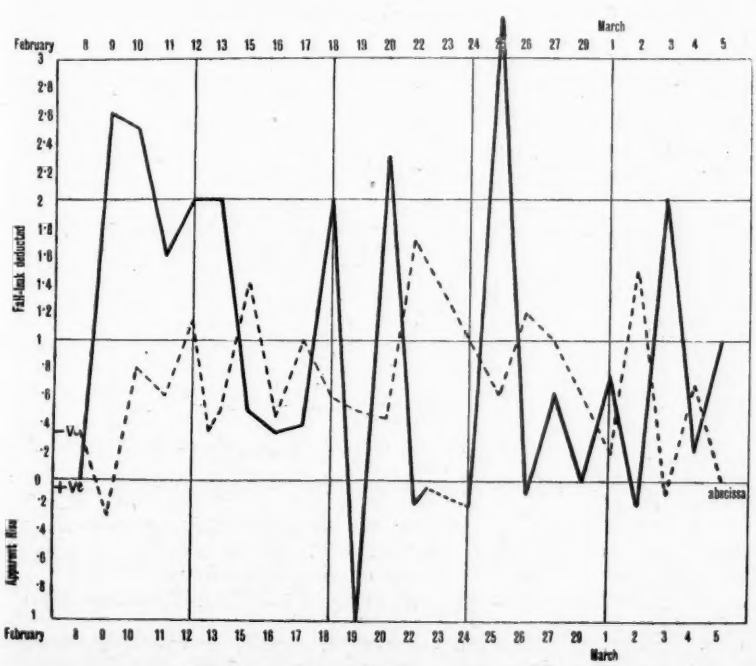


FIG. 2.

Very careful observations were made in order to ascertain whether the passage of ionised air would, under any circumstances, increase the divergence of the leaves, and the most hopeful occasion was on the last day of February, when the electroscope showed neither leak before the experiment, nor loss when air was being drawn. But even then it could only be said that the leaves were stationary, and if any increase did take place, as it seemed to one observer about the middle of the experiment, it had just disappeared by the time the final reading was made. A few days, however, subsequent to the last of the observations recorded here, an actual increase of the divergence of the leaves did occur. They were then set at about 1 cm. apart, so that ionised atmospheric air was shown to be capable of conveying a charge at a higher potential than that of the leaves divergent to the extent stated, capable also of parting with some fraction of its charge to them.

The instrument in use has now been slightly improved and rendered more sensitive by reducing to the very smallest proportions the wax rod which supports the gold leaves, and further by placing just under the leaves a diaphragm which ensures that the current of air will be more completely brought into contact with the electrified surfaces. The first improvement is a very necessary one, because it would appear that the wax has a certain capacity which must be satisfied before the normal leak is established. It has always been found that the first small charge given to the leaves slips away with considerable rapidity. When a second charge is conveyed to them, they presently become steady, and after about a quarter of an hour one may safely commence to record the normal leak. Care must be taken to sweep out the air that has filled the interior of the glass case when one kind of charge was upon the leaves before setting to work with the opposite electrification. I have again to thank Mr. W. Crampton Smith, B.Sc., for his able assistance, and I may be permitted to express the hope that other meteorologists may, as is so strongly urged in the REVIEW, proceed with similar observations.

A CRITICISM OF MR. JAMES SWINBURNE'S "ENTROPY."

BY ROBERT H. SMITH.

MR. SWINBURNE gives, as sub-titles to his book,* "Thermo-Dynamics from an Engineer's Standpoint" and the "Reversibility of Thermo-Dynamics," the last phrase applying to his British Association paper, which appears as an appendix to the volume.

The author did a great service to the science of thermodynamics by raising discussion upon the matter of his papers, because thermo-dynamics had become stereotyped into a conglomerate of mathematical equations concerning "reversible cycles"; that is to say, concerning certain cycles of physical action which have no physical existence, and which exist only as intellectual inventions. Mental processes are much more readily and much more frequently reversible in truly legitimate manner than are the processes of gross physics. It was, therefore, essentially brilliant wit to discourse upon the reversibility of the science thermodynamics, which is, of course, as all science is, a mental product.

In contradistinction to the reversibility of the reasoning establishing theoretical relations between thermo-dynamic facts, the irreversibility of the concrete results of the transmission of heat energy is the main proposition to which Mr. Swinburne desires to draw attention, and he finds that the thing called "entropy" is the best instrument to use

* "Entropy." By James Swinburne. Westminster: Constable and Co., 1904. Price 4s. 6d. net.

for the demonstration of this proposition. The proposition is the one of most fundamental and chief importance in the practical utilisation of heat, that is to say, in the use of heat by engineers. The proposition that "entropy increases in all heat transmission" is one way of expressing this fact of irreversibility. All economy in heat-engineering depends upon the scientific investigation of this irreversibility, and upon the careful measurement of its quantitative results. The present writer cannot see that entropy is the most fruitful means of research into this economic problem; but, undoubtedly, it is one means whereby a theoretical understanding of its main bearings may be attained.

Admitting to the full the great practical importance of the set of facts to the scientific recognition of which Mr. Swinburne has contributed so vigorous a stimulus, for which work he receives our grateful thanks and hearty congratulations, and deserves those of all scientific engineers, we have still to offer two serious criticisms upon his manner of doing it. In the first place, his theorising does not show a clear vision and a profundity adequate to the fundamental and essential character of the subject; and, in the second place, his mathematical detail developments are not accurate.

On the first count our main complaint is that we cannot find that he anywhere gives a clear explanation or definition of what is technically meant by the word "reversible." The meaning of this word, as used in thermo-dynamics, is highly technical and special to this one purely theoretic and mathematical science. It is because of the application of this quite special meaning to this word in this particular connection that all the confusion of idea that actually prevails has arisen; therefore the first essential in any attempt to clear up matters and put them straight is to come to close quarters with this phrase, and to explain fully and exactly its technical significance, the way in which it is used, and the deviation of this special meaning from the ordinary meaning of the word. It has not the remotest correspondence with the usual engineering sense in which the word is employed. A steam engine is, in ordinary language, made reversible by a mechanism whereby the kinematic relations between its valve motions and its piston motion are changed as regards difference of phase. What is here meant by the reversal of the engine is that the rotation of the crankshaft is reversed in direction. The source of power remains the same, and the delivery of power from the engine is unchanged.

In every other case of the common use in engineering practice of the phrase "reversal," there is an equally simple and matter-of-fact meaning attached to it. An electric motor gets reversed in the direction of its running by the reversal of its magnetic field. If the belt driving a dynamo be crossed so as to revolve the armature in the direction opposite to that caused with an open belt, the polarity at the dynamo terminals is reversed. If a fan be reversed, it drives—inefficiently, of course—the air current in the direction opposite to the normal. In no case is there ever any suggestion of turning the dynamic action of the machine inside out. If a turbine could be used as a pump—which it cannot be, because those in charge of turbines follow the elementary dictates of common sense—the change would not be referred to as a reversal. An electro-motor can be used—inefficiently—as a dynamo and, in braking action, is actually used so, but the change is not called a reversal, because there is no reversal of the kinematic conditions.

The technical thermo-dynamic use of the phrase is not here objected to. The point is that this use being so completely distinct and different from all ordinary and all engineering use, it is absolutely essential to explain very exactly its precise thermo-dynamic meaning to students of the science. This is the more essential, because so much depends upon this idea in the development of the science upon the plan that has up till now been adopted in the schools.

The essence of this technical meaning of reversal is that, according to it, the motion of the working surface is reversed in direction *without any other accompanying change of physical condition, either internal or external*, whereby the direction of transmission of energy from body to body by the method of mechanical work is also reversed. At the same time it is assumed that the direction of transmission of energy from body to body by the method of heat conduction is likewise reversed. This assumption is contradictory of the necessary condition that there is to be no internal or external change of condition except that of direction of motion; but this contradiction is a matter irrelevant to the purpose of this article and will not be further remarked upon. The present point is the necessity of a plain clear understanding of the meaning of the reversibility of the thermo-dynamic text-books, and the absence of its definite explanation from Mr. Swinburne's book.

The irreversibility of pure thermal action, by which is here meant the transmission of heat energy without transformation to other forms of energy, is the most important and fundamental law of heat-action. It is the law the consideration of which gave rise originally to the ideas of entropy and of dissipation of energy. In the origin, the increase of entropy and the concurrent dissipation of energy were put in the forefront as of first-class importance. Then there was discovered a conservative function for homogeneous material in uniform thermal condition throughout its volume, and this function was associated with the idea of entropy. The conservative function has been made extensive use of in the mathematical treatment of the subject, while the phenomenon of increase of entropy by heat transmission has been rather neglected and overlooked. Both ideas lead in different ways to what is called the second law of thermo-dynamics.

Mr. Swinburne's merit lies in his calling our attention forcibly to the non-correspondence between the mathematical theory of the formation of this conservative function $\left(d\phi = \frac{d\mathrm{H}}{\theta}\right)$ with any actual physical process. Because in this theory it is necessary to assume uniform temperature throughout the mass to which heat is conducted, an assumption which is (like the idea of reversibility) a contradiction in terms, because heat is conducted and distributed throughout material only in consequence of temperature gradients.

This objection is said to be removed by slicing the material up into very thin layers by sections normal to the heat flux, and using as divisor for each layer its average temperature. Whether this be so or not, it is only fair to note that none of our text-books give the student even the remotest hint that this differential method is required in any case, whereas it is actually necessary in every case.

It is in the mathematics of this differential treatment that Mr. Swinburne becomes inaccurate. He treats only the case of uniform temperature gradient, and assumes that the increase of entropy in any thin slice is the influx of heat divided by the temperature at the influx surface of the slice, while its decrease of entropy is the outflux of heat from it divided by the temperature at the efflux surface. With uniform gradient, the influx and the efflux are equal, H per second. The temperature at influx is, say, θ, and that at efflux $\theta - d\theta$. He divides H by each temperature, and takes the difference between the two quotients, and says this difference is a growth of entropy within the layer.

The excess at the surface of outflow over the value at the influx surface is

$$\mathrm{H}\left(\frac{1}{\theta - d\theta} - \frac{1}{\theta}\right) = \frac{\mathrm{H}}{\theta^2} \cdot d\theta$$

where $+d\theta$ is the drop of temperature from influx to efflux surface. By a curious error, this is written $\frac{\mathrm{H}}{\theta} d\theta$ on p. 136 This is a minor slip, although it is carried on into the deductions made from the result, for instance, into the volume integration of this differential which he recommends to be made. He speaks of the entropy passing through the mass, and of growing as it travels.

This conception of entropy evidently makes it a property of the heat-energy, and not of the energised mass. Its value is calculated at a surface, and not in a mass, or even in a volume. The volume integral just referred to is not entropy in the volume integrated through; it is growth of entropy resulting in new entropy outside this volume.

Mr. Swinburne manages, however, to reconcile this conception with the usual ideas of entropy in a mass and of a mass, and adds up the entropies of the different parts of a complex or heterogeneous mass.

But surely so soon as it is recognised that entropy, whether regarded as a function of energy or as one of mass-condition other than energy, resides in and belongs to particular masses, it should be seen that this calculation for a volume

in which the temperature gradient is uniform is a somewhat futile one; one, at any rate, that brings very little new knowledge. Because here, the flux being steady in time, there is no increase of heat in any part of the volume investigated, and therefore no change of entropy. Each thin slice loses just as much heat as it receives, and as the increase of entropy in a mass depends upon the integral quantity of heat conducted into it, therefore this increase is zero throughout the region and throughout the time in which uniformity of gradient reigns. A mathematical investigation of increase of entropy resident in masses should surely show in what masses the increase occurs, how it occurs in them, and to what amount.

If the differential method be applied with this object, it is at once apparent that its useful application is to regions where the temperature gradient is not uniform. It also becomes at once evident that Mr. Swinburne's distinction between surface temperature and mean temperature of the thin slice is not material so far as the divisor in $\frac{d\text{H}}{\theta} = d\phi$ is concerned. It is no more material than is the similar distinction in any other kind of differentiation and integration. Theoretically it is more satisfactory, and mathematically it is prettier, to use the arithmetic mean between the values at the extreme ends of the differential; but at the limit the same result appears whether the mean or either extreme be used in the computation. θ being the mean for any thin slice of thickness ds, and $\frac{d^2\theta}{ds^2}$ being the s-rate of variation of the temperature gradient $\frac{d\theta}{ds}$, and c being the coefficient of heat conductivity through the material investigated; then, $\frac{d\theta}{ds}$ being the negative gradient in the direction of heat flux, and $\frac{d^2\theta}{ds^2}$ being its positive increase or decrease of its negative value, a positive value of $\frac{d^2\theta}{ds^2}$ means that the efflux is less than the influx, c being assumed constant. The flux per second through any section of unit area being $-c\frac{d\theta}{ds}$, the increase of heat per second in the volume $1 \times ds$ is $c\frac{d^2\theta}{ds^2} . ds$, and therefore the increase of entropy in the same volume is $\frac{c}{\theta}\frac{d^2\theta}{ds^2} . ds$. It is the integral of this between limits of volume which gives the increase of entropy per second within that volume. It has no definite relation to the integral of $\frac{\text{H}}{\theta^2} d\theta$.

It may also be written $-\frac{1}{\theta}\frac{d\text{H}}{ds} . ds$, since

$$\frac{d\text{H}}{ds} = -c\frac{d^2\theta}{ds^2}.$$

Also, if desired, ds may be expressed as $ds = \frac{ds}{d\theta} . d\theta$. The time-rate of increase of entropy $\frac{d\phi}{dt}$ may then be written $\frac{d\phi}{dt} = -\frac{1}{\theta}\frac{d\text{H}}{d\theta} . d\theta$. The most important point to notice is that the increase of entropy arises in the masses through which there is curvature of the temperature gradient—upward curvature in the forward direction of the heat flux. A simultaneous decrease of entropy is probably occurring, necessarily in a region where the curvature of the temperature gradient is downwards in the direction of heat flux.

It may also be important to note that if c, the heat conductivity, be not constant along the path of the flux, then $d\text{H} = -\left(c\frac{d^2\theta}{ds^2} + \frac{dc}{ds}\frac{d\theta}{ds}\right) ds$, and the increase of entropy per second is $\frac{d\text{H}}{\theta}$ in the slice ds thick. It would be interesting to inquire closely what is the true substitute for this equation at sections where discontinuity of kind of material, and therefore of c, occurs—that is, at surfaces of contact of different materials.

This is the chief error we have noticed in Mr. Swinburne's mathematical developments; but on page 105 there is another curious instance of hasty and too superficial mathematical computation. Here he says that entropy calculated for unit mass from absolute zero of temperature is

$$\int_0^1 d\theta/\theta = \phi = \log.\ \theta_1 - \log.\ \theta_0$$

where $\theta_0 = 0$ and $\log.\ \theta_0 = -\infty$: "So the entropy needed to raise the body to any finite temperature is infinite." Now this assumes, in the first place, that the specific heat is unity, and, in the second place, that it is constant all the way up from 0° to θ_1. The true equation, is, of course, $\int_0^1 d\text{H}/\theta = \phi$; and if any one puts this out in pv diagram form so as to realise what its real physical meaning is, he will recognise how extravagantly impossible it is to find any path whatever up from 0° to θ_1 which will make the specific heat per degree of temperature constant down to 0°. Towards the limit 0° $\frac{d\text{H}}{d\theta} . d\theta$ also diminishes toward the limit zero independently of $d\theta$, as is evident from the crossing of the adiabatics and the isothermals.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Electricity Supply Accounts.

I notice with some surprise your remarks with reference to Mr. Burnett's letter on the Barrow accounts in the current issue of the Electrical Review. You cannot, surely, wish to imply that the maintenance of public lamps should be charged as a working cost of the electricity department. It would be as unreasonable to include the cost of scavenging the streets in the electricity accounts, as both this and the maintenance of public lamps are the expenses of other departments altogether. In many cases the Watching and Lighting Committee pay the wages and maintenance charges, as well as borrow the necessary capital.

It is obviously misleading and wrong to include these charges in the working costs of the electricity undertaking, and the only fair method, where the electricity department maintains the public lamps, is to keep a separate street lighting account, and include in the electricity accounts only the revenue from current and the costs of producing it.

I am sure that you, with your reputation for fair play and justice, will be the first to acknowledge that it is hardly fair to charge to one department the wages, &c., spent in cleaning and maintaining the lamps of another department.

Again, if, as seems evident from Mr. Burnett's letter, the sum for "Private mains and services" is ordinary service work on private property, this should be charged to capital and the amount received for same credited to capital. If, however, it is a repair, the usual method is to credit the distribution costs with the balance (that is £56 in this case) instead of burdening the working costs with a sum that is paid by someone else.

In order that these analyses may be useful for purposes of comparison, they should all be treated on the same basis, and this is only possible if all items which are not actually incurred in the production of electricity are carefully excluded from such accounts.

H. B. Maxwell.

Partick, *April 11th*, 1904.

Recent Developments in Metal Conduits for Electric Light Installations.

Were it not for the fact that "Doubleyou Ell" attributes to me a statement that never appeared in the unqualified and general way in which he has used it, I should not feel called upon to comment upon his statements in defence of the wood casing system, as, naturally, even a wood casing enthusiast is entitled to an independent opinion. The reference to my alleged admission that wood casing is cheaper to install than iron conduits is altogether misleading. What I remarked was that wood casing had somewhat the advantage in prime cost over light gauge conduit, but in the *cost erected* the light gauge steel conduit system had the lowest costs of any. In this I am supported by a number of leading contractors who have had considerable experience of

both systems, and are now confining themselves exclusively to Simplex conduits. "Doubleyou Ell" has either misread this particular part of my article, or has failed to differentiate between prime cost of material, and cost of installation erected.

The fact that "no one has claimed that wood casing is not inflammable," or that "it is so obvious that it absorbs moisture," is surely no argument why these admitted defects should not be recorded against it.

It comes somewhat in the nature of a surprise that any one presumably sufficiently experienced to criticise statements on conduit wiring should propound so elementary a question as the following:—"One would like to ask the advocate of the pipe system how the boast of erecting the pipes first and drawing in the conductors afterwards is to be managed after the pipe has been bent and twisted round obstacles."

It can only be inferred that "Doubleyou Ell's" experience is not altogether practical, for any wireman conversant with conduit work could inform him of the very ordinary practice of running a steel fish wire through a tube before setting it and subsequently employing a fish wire to draw through the cables, each length of tube being fitted with a split or inspection fitting or draw-in box.

The statement "With wood casing the workmanship exhibited on the outside of the system may be taken as a fair indication of the nature of the work hidden behind the cover of the casing," I entirely disagree with.

My experience, which is of no uncommon order, does not bear out the statement. With an equal amount of sublime confidence, one might expect to find a pretty girl in every stylish dress, or a head possessed of brains under every silk hat.

With reference to wood casing and mechanical protection, I can only repeat my assertion that practically no mechanical protection can be looked for from wood casing. The nail drivers, I may here mention, are a creation of "Doubleyou Ell's" mind. They were never mentioned in the article, but the fact that wood casing is used in places where there is no call for mechanical protection does not endow it with this property or enlarge its sphere of usefulness.

In conclusion, "Doubleyou Ell" appears to have exercised his mind in devising a *nom de plume*, and if, as is likely, W. L. are his initials, they are the reverse of mine, as are his views on the fitness of wood casing for general wiring. I think it would be more satisfactory, however, for such correspondents to append their names, as this might, in the present case, have added some further information to the somewhat vague opening of the letter, "as one interested in wiring."

The Writer of the Article.

April 11th, 1904.

[Without touching upon the merits of the question in dispute, we may assure our correspondent that "Doubleyou Ell's" experience in wiring matters is unimpeachable.—Eds. E.R.]

As one interested in wiring, and noticing in the Electrical Review, April 1st, an article on "Recent Development in Metal Conduits for Electric Light Installations," by Mr. L. M. Waterhouse, I shall esteem it a favour if you allow me to say a few words on behalf of the good old wood casing which, I notice, from time to time is attacked, and generally by those who are interested in some other method of wiring, steel tubing, &c. Wood casing has stood by the electrical engineer for fully 20 years, and long before steel tubing was thought about, and to-day holds its own in every respect. It is superior to steel tubing in many ways, viz.:—

More accessible for inspection of cables and jointing, &c. There are no or little accessories required, as in tubing, viz.—Elbows, tees, couplings, inspection bends and junction boxes, clips, &c.

It is cheaper in cost than tubing. Simpler to fix and offers less risk of damaging the cables or wires. It is acknowledged that a laying-in system, such as casing or other open conduit systems, is better than a drawing or threading-in system, there being less risk of damaging the cables.

Casing is rust-proof, whereas steel tubing in course of time becomes rusty. It is a fact that rust, especially with dampness, will decompose rubber on a cable, and in course of time the cables laid in a rusty tube will deteriorate and require replenishing. *Respecting mechanical protection*, which is considered the weakest part of wood casing, the writer of this article has seen many lengths of steel tubing where nails have been driven through, and this means making a short-circuit sooner, or more certain than what would take place should a nail be driven through a wooden casing, for the simple reason that the middle fillet in a casing being seldom less than ½ in. prevents a nail or screw uniting the two or more opposite poles, and, in fact, forms an insulated bridge between the two.

Insulation Tests.—The best insulation tests generally comes from a casing installation, especially when painted casing is used.

In conclusion, the writer superintended over 20 installations about 14 years ago, ranging from 100 to 1,500 lights, and all in wood casing, and having recently made inquiries, I am told in every case they are giving satisfaction. I do not wish to further trespass on your valuable space, and my concluding remarks are—Long live casing.

Yorkshireman.

Everyone who has much experience in installation work, and who does not depend for his living on the sale of metal conduits, will agree with your correspondent "W. L."

After all, it is scarcely necessary to take too seriously the statements of a writer, perhaps not entirely disinterested, who, in the course of a short article, uses such expressions as these:—

1. "Wood casing . . . . requires special labour at a high rate for its erection, which is necessarily slow. . . . ."
2. "The one thing that can be said in its [wood casing's] favour is its economy in first cost."
3. "There was an all-round demand for something . . . that would reduce the high cost and time taken in erection." [Still referring to wood casing.]

It would appear, therefore, that whilst a wood casing installation is very *costly*, its only recommendation is *its economy*, and later on we read that a socket joint conduit installation is the cheapest of any wiring system.

If there is no inconsistency here, the author of the article does not quite mean what he says.

B. F.

Information Wanted.—A correspondent wishes to know the quickest and most economical method of extracting platinum from large quantities of electric lamp ends.

Address Wanted.—A correspondent wants to know the address of the makers of the Cummins water-tube boiler.

REVIEWS.

Gas and Oil Engine Management. By M. Powis Bale. London: Crosby Lockwood & Son. 1903.

This is a small guide book to the use of gas and oil engines, which describes the method of fixing engines, the points to be observed in working them, and the faults which will arise and must be understood by the attendant. The author has written the book largely from his own experience, supplemented by the experience of makers and others, and has produced a very good little practical work which appears to contain just about the right sort of information for the class of readers for whom he has intended it. An error occurs in the definition of the indicated horse-power, which is said *not* to include the power required to drive the engine itself. This is just what it does include, which, if subtracted, leaves the brake horse-power. A few useful tables conclude the volume.

Modern Electrical Machinery and Apparatus. By Dr. F. Niethammer, Professor at the Technical High School, Brünn.

Although this book has less than 200 pages, the author manages to crowd in a mass of valuable information on modern dynamos, alternators, direct and polyphase motors, transformers, and switchgear, &c. Judging by the way the

matter is presented, it no doubt forms the basis of the author's own lecture notes, and his students are to be congratulated on having so up-to-date and judiciously selective a professor.

The writer has the utmost reverence for work done by pioneers and for historically interesting facts, but hitherto we have had a little too much of it in electrical text-books. The author's opening chapter deals with the heating and ventilation of a dynamo machine, than which there are no more important points. He then gives Thury's extra high voltage direct current work an appreciative notice, and however much one may think Thury is wrong, there is no doubt of his pluck in persisting in wrestling with the disabilities of the commutator machine.

The compounding of three-phase alternators is referred to, as also the question of equaliser rings for large direct current dynamos. A diagram of the special Arnold winding is shown, and also the Arnold pole shoe. The following data of two Union El. Ges. dynamos, both giving 100 KW. 110 volts at 200 revolutions, will be of interest:—

	8-pole machine.	14-pole machine.
Diameter of armature	1,780 mm.	1,500 mm.
Length of armature to diameter ...	·26	·23
Overall length of armature with commutator	850 mm.	660 mm.
Weight of armature without shaft ...	1,400 kg.	1,200 kg.
Weight of armature copper	110 kg.	145 kg.
Weight of field copper	340 kg.	310 kg.
Commercial efficiency	90·5 %	90·2 %
Ratio of iron loss to copper loss in armature	1·1	1·7
Temperature rise on armature ...	35°	30°
Temperature rise on field coils ...	38°	25°
Temperature rise on commutator ...	44°	33°
Position of brushes from no-load to 125 KW.	2 segments forward.	fixed position.

Stability of construction of alternator armature rings is discussed fully, and there are illustrations of vertical spindle machines, including the latest 7,000 KW. Niagara alternator with the poles *inside* the armature ring.

Two features in particular prejudice the reviewer in favour of the book; one is the excellent illustrations, and the other the voluminous footnotes giving references to articles in technical journals and to catalogues issued by various electrical firms. By inserting the latter the author has made his book a work of reference as well as a text-book, and it is a feature which other writers and compilers might well copy.

The book lacks an index, but no doubt this will be rectified in the next edition, which deserves to come soon. By the way, there ought to be an English edition.

Friction and its Reduction. By G. V. Wheeler. London: Whittaker & Co. 1903. Price 3s.

This is an excellent little treatise on lubrication in the main. The author has selected his facts from a wide area, and there is a good deal of information on friction and lubrication that has never yet been thoroughly abstracted and put into most useful form. Chapter V. deals with oil and lubricants in respect of their sources, flash point oxidation, volatility, and so on. The presence of grit and solid matter in oil is referred to as a warning in respect to the purchase of thick oil, which may be dark and thick, merely from such pernicious solid matter. The writer of this book shows up the possibilities of the oil trade from the point of view of one who does not quite believe in the oil manufacturer. Various oil testing apparatus is described. A chapter is given on ball-bearings, and a final chapter on forced lubrication.

Cylinder Oil and Cylinder Lubrication. By H. M. Wells. Manchester: The Henry M. Wells Oil Co. 1903. 3s. 6d.

This book is founded on a series of articles which appeared in the *Engineer*; though written by a trading concern on their special subject, it is kept clear of the trade influence, which reveals itself only in the advertisement pages tacked on at the end. Oil, and lubricating oil particularly, is in itself the subject of so much special knowledge that the best author should be an oil manufacturer, if he is in a literary sense quite honest. The excellence of an oil must depend on the crude material whence it is distilled. As there is a perfect statue in every piece of marble, so round a good oil are certain too light and too heavy constituents concealing it, and what is wanted is a good method of removing the objectionable parts. There was once to be had a certain black Virginia crude that could be used in its natural state, but this seems to have dropped out of the market. Of course, one cannot use oils which have an asphalt base in their crude form.

Some account of oil refining is given in this book, and there are several tables which should be useful. The illustrations consist merely of various engines and pumps and lubricators of various makers, which have only an indirect bearing on the subject in hand. The book is well printed and should be of interest to those in charge of steam plant, &c. This book represents the oil trade, so to speak, from the point of view of the ill-used oilman.

Electricity and Magnetism: An Elementary Text-Book, Theoretical and Practical. By R. T. Glazebrook, M.A., F.R.S. Cambridge: University Press. 1903. Price 7s. 6d.

We have learnt to expect, in Dr. Glazebrook's text-books' clear exposition and logical order of development of the subjects treated, and the present work confirms our opinion. There may be doubts as to whether it is best to commence the subject by a study of electric currents or of electro-static charges, but once the author has adopted the latter course, the method of treatment is, in its broad lines, prescribed. Up to page 27, all statements are made in the terms of the two-fluid theory of electricity, and the reader will be somewhat disconcerted by finding, on p. 28, that "when electricity passes from A to B, then A is said to be at a higher potential than B." This introduction of the one-fluid theory without any explanation is rather hard on the elementary student, for whom the book is written. Faults of this kind are rare, but in the eyes of an engineer the book is defective on its practical and technical sides. If a work claims to be "theoretical and practical," it should be both, and the good qualities of one part should not be allowed to justify inferior work in the other.

In the absolute measurement of a current by means of a tangent galvanometer, the student is told (p. 250) "the value of H may be taken in England as ·180 units," and we should like to know whether the laboratories and testing rooms where the value of H is notoriously not "·180 units" have all been expatriated. On p. 251 we find the mean value of the current through the instrument is obtained by taking the tangent of the mean of the deflections when the mean of the tangents should be taken. On p. 287, to prove by calorimetry the expression for the heat generated by the passage of a current through a wire, the student is told to connect up a battery of 5 or 6 volts through an ammeter and resistance box to a wire of 4 or 5 ohms, and is not told that, by so doing, he is more likely to damage the resistance box than to prove Joule's law. These examples are sufficient to show that the book cannot be taken as a guide in practical matters.

We turn naturally to the parts which treat of the technical applications of electricity, and are disappointed to find many of the mistakes which have been pointed out and still repeated in text-books for a generation. On p. 121, and again on p. 399, we have a magnetic flux passing from air to soft iron without refraction. Why should this simple matter prove so troublesome to Dr. Glazebrook, who in the past, no doubt, has ploughed students who showed a ray of light passing without refraction from air to glass? On p. 396 we have diagrams of dynamos with the long thin cores and thinner yokes of 30 years ago, while on p. 394 we are led to believe that by increasing the number of sections in an open coil armature we should arrive at a closed coil.

Some of the diagrams require improvement. These

showing the distribution of potential throughout the circuit of a voltaic cell when it is open and closed respectively on pp. 219, 220, &c., should be drawn to the same scale. The part of the "modern alternate current machine" shown in fig. 254 is very ancient, and has got turned through 90° in the printing.

Some of the diagrams of galvanometers, *e.g.*, figs. 233, 237, suggest that the instruments were "took" in the early hours of the morning, when they were returning to the National Physical Laboratory after a night's debauch in Teddington. Really, in a Government institution the instruments ought to be better behaved.

Construktion und Prüfung der Elektricitätszähler. By A. Konigswerther. Hannover: Gebrüder Jänecke. 1903. Price 9m.

This book is a complete treatise on the construction and testing of present day electricity meters. It has been, up to the present, comparatively difficult to obtain descriptions of, and information as to the working of, the various types of supply meters which are on the market. What information is available has had to be culled from makers' price lists, patent specifications, &c. Engineers who have to install meters, as well as those engaged in the manufacture of these instruments, will therefore welcome the publication of this book as bringing together and making readily available a very large quantity of valuable information.

It is a common fault of books of the character of the one under review that the information therein contained is already antiquated at the time of its publication, and thus possesses little but historical value. This cannot be said, however, of the present volume, which is practically quite up to date.

The book is divided into three parts; the short first part (19 pages) gives the general equations and principles on which the design of supply meters rests. The second and longest part describes the practical construction of the various meters, and is divided into five sub-divisions which treat of recording instruments, instruments with periodic addition, integrating meters, special meters, and general constructional details. As the book is primarily concerned with integrating meters, that sub-division which treats of these comprises the major portion of the work. The third part is concerned with meter testing, while at the end a number of typical test sheets, &c., as used by different manufacturers are given.

Great pains have been taken with the illustrations; not only are reproductions from photographs given, but also diagrams illustrative of the working principles and the internal and external electrical connections.

The method of treatment adopted is to give a short theoretical explanation of each instrument, followed by a description of the construction of the actual manufactured article. A noteworthy feature is the excellent manner in which the clock diagrams of the various alternating current meters are given and explained.

The chapter on induction watt-hour-meters contains a very good summary of the various methods which have been adopted for getting the shunt flux to lag exactly 90° behind the series current flux on non-inductive load. The complete theory is worked out which shows that this exact lag of 90° in the flux is a condition of the accurate working of the meter on inductive load. This chapter will especially appeal to anyone who has had anything to do with the manufacture of induction alternating watt-hour-meters, as the securing of the 90° lag is the first problem to be got over. Most practical methods have already been patented by different manufacturers. It has therefore come about that many ways have been devised to secure the same end, the diversity of method being caused by the necessity of not infringing somebody else's patent. There is no doubt that, when the various patents have had time to expire, many of the constructions at present used will disappear in favour of one or two which will have shown themselves to be better than all the others. No doubt, the simplest way, and that one which will eventually survive—at any rate, for small meters—is to so construct the iron of the shunt circuit that the eddy currents induced in the same give the necessary retardation to the shunt current working flux with regard to the shunt current, and therefore to the series current working flux. A small auxiliary regulating device, such as damping rings or a secondary closed winding round the shunt pole, gives the required small range of adjustment. It must be borne in mind that the 90° lag is between the two fluxes just where they pass through the driving disc. The actual current round the shunt magnet is not in quadrature with the series current. On this simple principle depends one of the latest types of alternating current meter, the Ferranti-Hamilton, the description of which, however, does not yet appear in the work under review.

An interesting chapter to meter manufacturers is that on the details of construction of motor meters, in which such questions as bearings, jewels, static friction, &c., are dealt with. The descriptions of the various forms of demand indicator, double-tariff meters, and prepayment meters are also fairly adequate. It is, however, to be wished that the chapter dealing with the use of current and pressure transformers were more complete. What is said is very useful, but reliable information as to the degree of inaccuracy introduced into integrating meters when used in conjunction with transformers is very much to be desired. The last part of the book deals with matters of testing, &c.; from the descriptions of various laboratories therein given many hints may be obtained. The book is well indexed, and we recommend it to all interested in meter work. An English translation is much to be desired.

MARINE TURBINE STEAMERS.

The decision come to by the Cunard Co. to fit their large new boats with turbines is, undoubtedly, one of the most momentous in steam engineering for many years. It is the more remarkable in that the expected economy in weight is so very trifling, some 2 or 3 per cent. only. There are, of course, many factors which enter into the calculations as to the advantages of turbines. It will be possible to put four shafts on which there will be four propellors. The idea of more than one propellor on each shaft has been abandoned, if ever it was entertained, on behalf of large vessels. It will be possible to run these four shafts at a high rate of speed, and this will enable the dimensions both of the shafting and of the propellors to be kept within smaller limits. With a total of nearly 73,000 H.P. there will still remain nearly 18,000 H.P. to pass through each length of shafting. It is well known that the turbine works best at one load. The provision of four turbines will enable the speed to be reduced to about three-quarters by cutting out half the propelling power without reducing the economy of the remaining sets. The four shafts, moreover, afford great possibilities in the way of immunity from complete breakdown, and all that this involves, for even at half power the speed will be higher than that of all but fairly modern boats.

The engineers who constituted the committee appointed to investigate the subject, and whose opinions have justified the company in coming to the decision they have formed, are all men of standing and ability, and have, doubtless, satisfied themselves fully on the merits of the turbine in principle. The experiment is a great one, for it may still be classed as an experiment, though there are good but smaller precedents in certain channel steamers and opportunities for making tests and arriving at figures to assist in the new designs. Engineers will watch with interest the results of the bold departure which, when made, will fix the future of the turbine for several years to come for good or ill as a motive power for large vessels.

Hartlepool Tramways.—The T.C. has entered into an agreement with the General Traction Tramways Co., Ltd., for the leasing of the tramways. The company will pay to the Corporation one-third of the profit over a sum equal to 7 per cent. on the capital expenditure.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Lear" writes:—"I have agreed to sell to a firm of electrical engineers an invention of mine, which I have patented, the patent papers of which I still hold. By written agreement, they have paid me a small sum down, and were to have paid the remainder, as stated in the agreement, by the 6th of this month. They have failed to do so. Does the agreement still hold? and am I at liberty to sell my patent elsewhere? also, do they forfeit their payment?

*** Upon the facts, as above stated, it is clear that an action brought against the firm in question for arrears of purchase money would prove successful. It is feared, however, that, the property in the letters patent having passed to the firm of engineers, "Lear" has no further remedy against them, nor can he rescind his contract, nor dispose of the patent rights to any third person. If he contemplates bringing an action, he should consult his solicitor.

THE ACTION OF RADIANT HEAT.

A novel theory of radiant heat is hinted at by our contemporary, the *Engineer*, which has indeed, with a certain consistency, long held forth views in regard to radiant heat that would appear to be somewhat subversive of accepted theories of energy. The view taken is illustrated by the following example, which is put forward as having been actually tried and proved. At least, so we read the assertion, as to what would happen should the experiment be repeated. This experiment is as follows or on these lines:—

Take two pieces of heated iron of equal weight and temperature. Place one of them inside a small water-jacketed box, and the other inside a large jacketed box. When the iron in each case has cooled through, let us say, 1,800° F., or any other range of temperature, more heat will be found to have entered the water surrounding the small than the large box, the reason being that the iron is nearer to the surface to be heated in one box than it is in the other. Yet no heat can have escaped in either case, on the assumption that the box being closed, all heat has been intercepted by the enclosing water boundary, and distance should not have had any effect. Heat rays, as we may still term the radiant emanation which we know as heat, may be represented as lines of force, and temperature is simply a function of the lines of force, many lines in a given area corresponding with high temperature and *vice versâ*. Obviously, in a closed box, the surface to be heated is exposed to the higher temperature, as it is nearer the source of heat. But this does not, of course, explain the absolute disappearance of energy in one case and not in another. Experiments which show this disappearance of energy must always be looked on with some suspicion. Were proper corrections made? A large box loses heat by radiation to a much greater extent than one of smaller size, and errors may easily creep in from this cause alone.

If it be proved, however, that with all calculations energy really has disappeared, then it follows that low temperature radiant heat, or that quality of radiation which has few lines of force per square centimetre, has the power of passing through certain substances, such as iron plate or water, more readily than have the more concentrated rays. Water and iron plate are, in fact, diathermanous to radiant heat, possibly in a certain ratio to the surface exposed to it, and thus arises the advantage of small surfaces and contiguity of the hot body to such surfaces.

Another illustration of the claimed phenomenon is, that large locomotive fire boxes have failed where they ought to have been a success, and this is held to be accounted for by the greater distance from the walls of the box of the source of radiation. We are not satisfied that our contemporary has proved its claim. The statements are put forward very much *ex cathedra*, and not particularly tentatively. If true, they ought to be capable of clear and unmistakable proof, and there should be means, also, of discovering whether the escaping radiant heat is outside the large box to the extent of the missing quantity. If neither in the box nor in the jacket water, nor escaping in some other guise, then, indeed, would the theory of energy have been shattered like a clay idol. From the tone of our contemporary, two exactly similar boilers, except for the size of the fire box above the fire level, should show different evaporative effects; yet the boiler which produced the least steam would not reject its gases any hotter. The point is important, for we are being asked to believe that a certain portion of the heat of fuel disappears simply by virtue of passing a few additional inches through space. The lay mind is always liable to become confused as between heat and temperature, and probably no better explanation can be given of temperature than that embodied in the idea of concentration of lines of force.

The common lens or burning glass, which collects what appears to us as but the genial and pleasant warmth of the too infrequent sun, will focus these rays to a point of heat intensity that will fuse the most intractable of substances. Yet, beyond the focal point, the same original rays will reappear with no such intensity. Temperature is then clearly a concentration effect, and it is very difficult to believe that want of concentration has altered the properties of radiant rays. Something certain with positive proof is demanded; mere vague claims and statements unsupported by experimental proof cannot be accepted.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 15th, 1903.		Week ending April 12th, 1904.	
Adelaide	Value £17	Adelaide	Value £92
Buenos Ayres. Teleph. cable ..	125	Alexandria	167
Calcutta	492	Amsterdam	130
Cape Town	101	Bombay	1,854
Colombo	128	Buenos Ayres	85
Durban	66	Calcutta	220
Hong Kong	17	,, Teleg. mat.	35
Karachi	40	Cape Town	181
Melbourne	497	,, Teleg. mat. ..	101
Perth	92	Colombo	42
Port Elizabeth	24	Durban	928
Rotterdam. Teleg. wire ..	35	,, Teleg. mat.	964
St. Petersburg. Teleg. wire ..	2,494	East London	256
Singapore	22	Gibraltar	698
Sydney	722	Hamburg. Teleg. mat. ..	26
Wellington	71	Lisbon	88
Yokohama	788	,, Telephones	57
		Madras	248
		Melbourne	111
		Nagasaki	177
		Odessa	270
		Perth	87
		Port Elizabeth	27
		Rio Janeiro. Teleg. mat. ..	370
		St. Petersburg. Teleg. cable ..	400
		Sarawak	135
		Sydney	490
		,, Teleg. mat.	210
		Wellington	662
		,, Teleg. mat. ..	1,417
		Yokohama	21
Total ..	£5,731	Total ..	£10,369

Foreign Goods Transhipped.

Boulogne. Elec. mat.	Value £100
Flushing. Elec. mat.	240
Lisbon. Elec. instr.	160
Ostend. Elec. goods	85
Total	£585

Browett-Lindley Engine Contracts.—Messrs. Browett, Lindley & Co., Ltd., have lately booked the following orders:—

From Messrs. W. P. Theermann & Co., of Manchester, for an 80-kw. engine and dynamo, for Messrs. Porrits, Sunny Bank Mills, Helmshore.

From the British Westinghouse Electric & Manufacturing Co., Ltd., for a 150-kw. engine for the Longford Wire Co., Warrington.

A 250-h.p. engine for dynamo driving, from Messrs. J. M. Sumner & Co., for Russia.

An engine, from the New Explosives Co., Stowmarket, for driving a 50-kw. dynamo.

From the Electrical Co., London, for one of their Standard engines (for 60-kw.) for the Irwell Bank Spinning Co.

Trade Announcements.—The Reason Manufacturing Co., Ltd., of Brighton, have decided to much enlarge their Street Lighting Department. As announced in our last issue, they have engaged Mr. Hadyn T. Harrison, M.I.E.E., to manage the department, and have opened offices at 11, Victoria Street, S.W., where all inquiries should be sent. We are informed that it is the intention of the company to undertake all classes of electric street lighting, and that they will shortly be issuing a pamphlet dealing with the subject.

Messrs. W. T. Glover & Co., Ltd., of Trafford Park, have appointed Mr. John Ardrey, Granville Buildings, 43A, High Street, Belfast, to represent them in Ireland. A large stock of vulcanized wires and cables is kept in Belfast.

Messrs. Barry, Head & Co., of 26, Lombard Street, E.C., announce that in consequence of Messrs. Cochran & Co., Annan, Ltd., having gone into voluntary liquidation in December last, with a view to reconstruction, their agency for that company was abrogated. They have accordingly now made arrangements with Mr. James Blake, of Middlesbrough-on-Tees, whereby they become his sole agents, in London and district, for the sale of the "Blake" vertical multitubular boiler.

We are asked to state that with the current number (published on March 25th) the *Electro-Chemist and Metallurgist* has been reduced in price to 1s. per copy without any reduction in the volume of its contents.

Mr. William Lowry has resigned his position as engineer for the Insurance and Maintenance Co., Ltd., of 100, St. Martin's Lane, W., and has been appointed to represent Messrs. Edwards & Armstrong, of Bristol and Cardiff, at their new London office, 18, Bury Street, W.C. The firm has secured the contract for lighting the Manchester Hotel, Aldersgate Street, E.C., and is at present engaged fitting up the new Town Hall and Law Courts, Cardiff, with lighting and telephones.

Mr. H. H. Clements, A.I.E.E., has lately left the Alliance Electrical Co. and has joined the firm of Clements, Booker & Co., of 3, Victoria Street, Westminster, S.W., and Aston Manor, Birmingham.

The Manual of Electrical Undertakings, Ltd., has changed its name to the Electrical Press, Ltd., and its new address is 37 and 38, Strand, and 1, Buckingham Street, W.C.

Duty on Electrical Machinery for Sweden.—A Reuter telegram from Stockholm states the Riksdag has passed, by 215 votes to 148, the Bill imposing an *ad valorem* duty of 15 per cent. on electrical machinery.

Naval Officers at Queen's Engineering Works, Bedford.—In connection with part of the new scheme which the Lords Commissioners of the Admiralty have in hand for the training of officers in His Majesty's Navy, a visit of inspection was paid by the Torpedo-Lieuts. of H.M.S. *Vernon*, which is at present stationed at Portsmouth, to the Queen's Engineering Works, Bedford (Messrs. W. H. Allen, Son & Co., Ltd.), on Thursday, March 24th last. The course of instruction given on board H.M.S. *Vernon* is intended for a certain number of selected candidates who wish to further qualify in the service as torpedo lieutenants, and consequently much of the time occupied by the course is devoted to the study of torpedoes, mines and electrical appliances connected therewith. The object of such visits is primarily to enable those who will eventually be responsible for the proper working of various types of machinery when afloat, to obtain a thorough practical acquaintance with the most modern methods of construction and design of such high-class machinery as is employed in the equipment of the modern man-of-war. The series of visits to some of the principal engineering works in the United Kingdom, which have for some years past been engaged in executing extensive contracts for the Admiralty, were inaugurated last year by a visit to the Queen's Engineering Works. The choice was an obvious one, as Messrs. Allen have during the last 10 years supplied the complete electrical equipment for many of our largest liners of the Atlantic service. The directors of the company have again this year had the opportunity of entertaining a party of officers from H.M.S. *Vernon*, and this obviously pointed to the fact that their former visit was productive of good results. This year the party consisted of 22 members, who arrived at the works at about 11 a.m., and were received at the main offices by the directors of the company. Almost immediately they commenced their tour of inspection of the works, being escorted by members of the works' staff. At one o'clock lunch was served in the pupils' lecture hall, the afternoon being devoted to a further inspection of the workshops and the various processes employed in the manufacture of mechanical and electrical machinery. The visitors, as was expected, gave particular attention to the electrical department, and viewed with great interest the different stages in the evolution of the modern dynamo-electric machine, and especially of the machines of the company's Admiralty types. The methods of construction and the plant employed in Messrs. Allen's workshops represent the most recent developments in modern shop practice. For some years past all work has been done to limit gauges, so that all parts of the company's standard types of machinery are interchangeable, and manual labour has been thus reduced to an absolute minimum. Several members of the party were among those who visited the works last year, and these remarked upon the noticeable advances made by the company in workshop methods, organisation and equipment.

Dissolutions and Liquidations.—The Natural Gas and Power Co. is winding up voluntarily with Mr. W. B. Peat as liquidator, and particulars of debts, &c., have to be lodged with Mr. Peat at 3, Lothbury, E.C., by May 3rd.

A meeting of the Auxiliary and Light Railways and Tramways Co. is to be held at 20, Victoria Street, S.W., on May 11th, to hear an account of the winding up from the liquidator, Mr. F. G. A. Hitchcock.

Messrs. D. L. Selby Bigge, R. G. Bell, and G. H. Bowden (D. Selby Bigge & Co., electrical contractors and engineers, Newcastle-on-Tyne, &c.), have dissolved partnership so far as concerns G. H. Bowden. The two other partners will attend to debts, &c.

Electric Generating Stations, Ltd., of Manchester, is winding up voluntarily with Mr. P. F. Huddleston, 72, Finsbury Pavement, E.C., as liquidator.

A meeting of the Electric Lighting Boards (British Manufacturing Co.) is to be held on May 13th at 75, Aldermanbury, E.C., to receive an account of the winding up.

Messrs. E. G. Warren Smith, W. B. Smith, E. W. Smith, and J. M. Smith (Warren Smith & Co., electrical and gas engineers, of Chelsea) have dissolved partnership so far as concerns Mr. E. W. Smith, who retires. The business will be continued by the remaining partners under the old style.

Creditors under a deed of assignment executed by A. S. Redick, electrical engineer, Market Street, Dewsbury, who have not already sent in their claims, must do so not later than April 16th (A. Greenwood, Market Street, Dewsbury, trustee).

A first and final dividend of 1s. 6⅝d. in the £ is payable on April 16th (Official Receiver's office, 17, Hertford Street, Coventry) in *re* Hooley, Talbot & Co., electrical engineers and contractors, of Rugby.

Electrical Machinery in Germany.—There was a large increase in the exports of electrical machinery from Germany during January last, returns just issued showing a total of 1,346 tons, as compared with only 1,062 tons in the corresponding month of last year. There has also been an increase in the imports of foreign electrical machinery into Germany from 52 tons in January, 1903, to 110 tons in January last.

Plant for Sale.—The East Ham U.D.C. is inviting offers for a 150-I.H.P. Musgrave engine coupled to a 100-KW. Dick-Kerr direct-current generator, consequent upon alterations at the electricity works. See our advertisement pages to-day.

Catalogues.—The Edison and Swan United Electric Light Co., Ltd., have sent us four new Ediswan leaflets, enclosed in a new binder, bearing on the front cover the legend "'Ediswan' Electrical Supplies." This binder is intended to hold the new series of catalogue sections and leaflets now being issued by the company. Later on, when the series is complete, it is hoped to issue a bound catalogue. Of the new leaflets to hand, No. L2,024 describes the new pattern "Queen of Lamps," with loose opal reflector and patent adjustable sleeve, as shown below. The new shape of this lamp, together with the fact that the reflector completely covers the filaments, gives it enhanced reflecting powers; a lamp rated at 16 C.P., and taking ·58 ampere, being capable of concentrating 32 C.P. in a vertical direction with an efficiency of 1·8 watts per candle-power. The patent adjustable sleeve makes a neat finish by covering the usual gap between the lamp cap and the holder; it also keeps the

reflector firmly seated on the lamp. Leaflet No. W2,029 describes the company's pure rubber flexible cords, and No. G2,030 shows the fountain shade, a device constructed of glass tubes and beads, which gives a beautiful lighting effect. Leaflet No. A2,031 describes and illustrates a complete range of the "Wedge" tumler switches—an improved type of point switch, which does away with all the usual gear under the lever, so that the china bridging piece has a free and recessed travel right across the china base. The patent spring is inside the screw collar, and high insulating qualities are combined with quick positive snap-off action, small dimensions, substantial terminals, wide break, and good contact. The "Wedge" switch has met with great success.

Mr. G. Braulik, of Upper Thames Street, has issued a new price list of "Eclipse" miniature arc lamps for alternating current circuits.

An excellent catalogue of 140 pages, just issued from the press by Messrs. Isenthal & Co., of Mortimer Street, W., covers a very wide range of apparatus for electro-therapeutic purposes, and is necessitated by the recent rapid growth in this very important branch of science. Some prefatory comments tell with satisfaction that the new era of electro-therapeutics is marked "by the disappearance of the old empirical happy-go-lucky methods of application." The catalogue describes the kind of apparatus that is needed for serious and efficient work, and omits "so-called *sets*, which have nothing to recommend them but cheapness!" Old models have been omitted, and many of the lines shown embody modifications and improvements, which have been made as a result of the latest experience. It is unnecessary for us to particularise the various apparatus in detail; a mention of the different sections will suffice to indicate the ground covered. They are: Röntgen ray apparatus, high frequency and vibratory massage equipments, photo and thermo-therapeutic apparatus, switchboards to connect with public supply, baths, surgical illumination, and many instruments, motors, and machines, also radio-active substance. The catalogue is convenient in size (8½ × 5½ in.), well laid out, and fully illustrated.

A leaflet has been received from Messrs. R. W. Blackwell and Co, Ltd, particularising their new patent section insulator (type B), and enumerating the many good points claimed for it.

A number of other lists, also received from Messrs. Blackwell, give particulars of their "Fludor" soldering stick, "Everight" charging sets, rubber cable connector, hurricane desk fan, and their "Arkless" enclosed switch fuses.

Messrs W. H. Bailey & Co, Ltd., of Salford, have issued a 20 pp. pamphlet (a section of their catalogue) detailing and illustrating their "Vivaxo" water gauges with reversible and renewable seats and scavenger attachments.

A booklet has been brought out by Messrs. W. H. Willcox and Co., of Southwark Street, S.E., giving details of their various motor engineering specialities as exhibited by them at the recent motor show at the Crystal Palace.

A new pamphlet relating to the Luna flame arc lamps has been issued by the Electrical Co., Ltd. The continuous-current and the alternating perpendicular and converging types are illustrated, and choking coils and transformers are also included.

A 1904 price-list of woven glass accumulators, induction coils and electrical ignition devices, has just been issued by Messrs. Van Raden & Co., Ltd., of Coventry.

From Messrs. S. Rawlinson & Sons, of Blackburn, we have received a catalogue of their cable and tower wagons, &c., for overhead equipment. The illustrations show a telephone hand-cart, and cable drum and reel wagon as supplied to the Glasgow Corporation, tower wagons as employed on the Gateshead electric tramways, hand carts and ladders for electric lighting companies, jointers' combined hand-cart and tent, tramway construction and repairing wagons, and other special lines of similar character.

From Messrs. J. E. Spagnoletti & Co., of Goldhawk Works, W., we have placed before us a finely illustrated catalogue of the Stigler lifts, of which they are the sole agents and manufacturers in this country. The pictures include electric passenger lifts as used at a number of Continental hotels and other public buildings, hospital lifts, hydro-electric lifts, direct-coupled electric passenger and goods lifts, and electric goods lifts at Genoa Docks. It is stated that some 4,500 of the Stigler lifts are in service in Europe. We have also received from Messrs. Spagnoletti a "Stolzenberg" file containing a number of lists relating to the firm's manufactures, such as street panels for tramways and lighting, switches, measuring instruments, fuses, circuit-breakers, battery regulators, and so on.

Book Notices. — *Elektro-Akustische Untersuchungen.* By R. Hartmann-Kempf. Frankfurt A.M.: Gebrüder Knauer. 1903.—In this masterly treatise the author deals with the influence of amplitude, &c., on the pitch and decrement of tuning forks and steel tongues, giving the results of a comprehensive research carried out in the Physical Institute of the University of Würzburg. The subject is dealt with both theoretically and practically in the painstaking and thorough manner for which German physicists are justly renowned, and the results are embodied in the present work, which has been produced in luxurious style. The photographic method of recording the amplitude and wave form of vibrations has been freely utilised, and the devices adopted for carrying out the research are both interesting and ingenious. Electrical apparatus bulks largely in the experiments, and the effects of resonance with alternating and intermittent direct currents are investigated. The most striking feature of the work consists in a remarkable set of photographic reproductions of records of vibrations obtained in the course of the investigation, which are bound up with the book. The volume has been produced apparently regardless of expense, and must prove of great value to those engaged in pursuits involving a knowledge of the phenomena in question.

The Indicator Handbook. Part I. By C. N. Pickworth, Wh.Sc., Manchester: Emmott & Co. 1904. Price 3s. net.—This is the second edition of a work which has become deservedly known as an excellent practical treatise on "The Indicator: its Construction and Application." All the well-known indicators are described and critically discussed, and the mode of attachment of the indicator, the arrangement of the reducing gear, and the proper use and care of the instrument, are treated of with minute attention to detail. The more recent forms of indicators with external springs and differential springs are included in the new edition. The work, as regards both the matter and the manner of its production, needs no recommendation, its merits being beyond dispute.

Twenty Years' Railway Statistics. 1884 to 1904. London: F. C. Mathieson & Sons. 1s. This is not a compendium of engineering statistics relating to railways and railway equipments, but it is a book which cannot fail to be of interest and service to all who are concerned with railway securities, the dividends paid on the capital, highest and lowest market prices, mileage open, receipts, percentage of expenses to receipts, and other like financial information respecting the principal railways both at home and abroad. Electrical engineers who are paying attention to railway electrification possibilities might also find it a useful work to have at hand.

"Elementare Vorlesungen über Telegraphie und Telephonie." By Dr. Richard Heilbrun. Part VI. Berlin: Geo. Siemens.

"Radium and All About It." By S. Bottone. London: Whittaker & Co. 1s. net.

The Estate Magazine. London: Spottiswoode & Co.

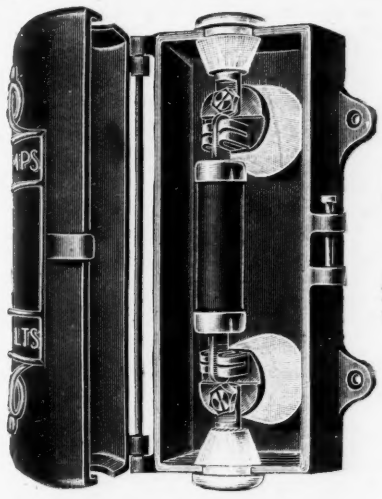
"Electricity and Matter." By J. J. Thompson, D.Sc. Westminster: Archibald Constable & Co., Ltd. 5s. net.

The special annual number of our contemporary *Timber* (March 30th), contains an illustrated article on "Electricity as Motive Power in Saw Mills," discussing the economies obtainable by its use, and describing electric wood-working plants at Putney, Bromley and Warrington.

Shipley v. Bryan, Donkin & Clench, Ltd.—In the Chancery Division of the High Court of Justice on Tuesday (April 12th), Mr. Justice Joyce had before him a motion in this action by which the plaintiff asked for the appointment of a receiver and manager of the defendant company, which carries on business as electrical and general engineers at Chesterfield. Mr. Hamilton, K.C., for the plaintiff, said his client held £10,000 "A" debenture stock, and £5,500 "B" debenture stock in defendant company, out of an issue of £100,000. The company had made default in the payment of interest due on January 1st last, and as there were valuable contracts to be carried out, it was necessary that a receiver and manager should be appointed. Mr. Justice Joyce appointed a receiver and manager as asked, and gave him liberty to act at once.

The Transvaal.—The value of the electric cables, wire, and fittings imported into the Transvaal last year, is officially returned at £65,000, as compared with £45,000 in 1902.

Some New Electrical Accessories.—We have received from the General Electric Co., Ltd., of 71, Queen Victoria-street, a monthly progress sheet, containing particulars of their "Pedestal" type of cut-out in cast-iron case, which has been specially designed for high voltage work, and can be supplied with either plain or spring clip terminals—the latter to take a Mordey fuse. Two new



designs of radiators of artistic and pleasing finish are shown, and this firm's well-known lines in dry and storage batteries. Somewhat of a novelty is shown in a lamp testing ammeter—which may be inserted between the lamp and lamp terminal, affording a cheap and ready method of gauging the efficiency of the lighting in a large establishment.

Automatic A.C. Pressure Regulator.—An apparatus for automatically regulating the pressure of alternating current generators has been devised by Messrs. Victor Bornand & Co., of Victoria Square, Birmingham. The mode of working the apparatus is to vary the exciting current by means of a rheostat controlled by a hot-wire device; a platinum wire is connected in series with a resistance between the terminals of the alternator, and, by its extension or contraction, actuates a balanced click mechanism, bringing into action a mechanically driven regulator geared to the rheostat. When the normal voltage obtains, the apparatus remains inactive. The full range of regulation, from full load to no load, can be covered in 15 or 20 seconds, or even less, if necessary. The mechanism is so constructed that the switch can never rest in intermediate positions between contacts. A number of alternators can be regulated by a single controlling apparatus, and the device can be used for varying the resistance in circuit with the alternator field or the exciter field, or with feeders, for controlling the transforming ratio of transformers, for regulating the speed of engines or turbines, and controlling electric furnaces, the range of pressure variation being ½ per cent.

Harris-Anderson Patent Feed-Water Filter.—We regret that an error occurred in our recent article on West Ham electricity works. In referring to the capacity of the Harris-Anderson purifying plant, we said that it was capable of dealing with from 1,000 to 1,600 gallons of water per hour; this should have read—from 1,000 to 16,000 gallons per hour, a very different matter. The plant in question is the largest of its kind that we have yet met with, and according to the Council's late electrical engineer, Mr. J. K. Bock, very excellent results have been obtained from it.

B.T.H. Arc Lamps.—Among the recent orders secured by the British Thomson-Houston Co., Ltd., for their arc lamps, are the following:—For the West Ham Corporation, 195 continuous-current, double-carbon open arc lamps for street lighting. For the North-Eastern Railway, 285 110-volts continuous-current multiple enclosed arc lamps for lighting workshops; 600 7½-ampere multiple-alternating enclosed arc lamps, 40 cycles, for lighting railway stations; besides 100 compensators for operating the alternating-current lamps from a 250-volt circuit. This order for the N.E. Railway, we are informed, was placed after, and as a result of, severe competitive tests, lasting over six months. An important point is that the alternating-current lamps are to operate on a 40-cycle circuit. It is only lately that arc lamp manufacturers have been able to supply enclosed arc lamps which would operate satisfactorily on circuits of 40 cycles.

Tunbridge Wells Electric Lighting.—The T.C. has received an order of £80,000 from a private London company for the borough electric light works, this being £10,000 more than the cost of the works up to date. In the Council opinion as to the advisability of selling the undertaking is divided, and decision of the question has been postponed.

LIGHTING AND POWER NOTES.

Arbroath.—A dispute has arisen in regard to the agreement between the T.C. and the Empire Electric Light and Power Co. It is stated that the Council had come to an agreement with the company whereby the former were empowered to take over the undertaking from the company at a given time in two alternative ways, but the company now wish to give the Council one way only of acquiring the undertaking. The T.C. has resolved to adhere to its original agreement with the company.

Ayr.—The T.C. has resolved to apply for sanction to borrow a further sum of £15,000 to carry out extensions recommended by its electrical engineer.

Berwick.—The formal opening of the Urban Electric Supply Co.'s power station took place on the 7th inst. The ceremony of switching on the supply to the town was performed by the Mayoress.

Birmingham.—In connection with the comprehensive electrical scheme foreshadowed in the report of the Electric Supply Committee, and mentioned in our last week's issue, some further details are to hand. As projected, the power station consists of an engine house 275 ft. long, 100 ft. wide, and 65 ft. high. On one side will be situated the boiler house 275 ft. long, 98 ft. wide, and 60 ft. high, with a coal store of 2,000 tons capacity overhead. Parallel to the boiler house an economiser house will be erected, and two chimney stacks 230 ft. high and 15 ft. internal diameter. Between the station buildings and Birmingham and Fazeley canal, which forms one boundary of the site, will be situated a pumping station for providing circulating water. The remaining buildings comprise workshop stores and battery room.

It is proposed to divide the engine house by a central gangway, and to install H.T. plant on one side, and L.T. plant on the other. Four 2,500 H.P., and three 900-H.P. high-speed engines, coupled to three 1,500-KW. D.C. generators, one 1,500-KW., and three 500-KW. A.C. generators are proposed, each set to have its own surface condensing plant; one 500-KW. D.C. turbo-generator and condensing plant; steam-driven exciters; motor-generator; converter and transformer, balancers, traction battery, 2,500 ampere-hours, boosters, H. and L.T. switchgear, and a 40-ton overhead electrical crane are included in the engine house equipment. The circulating plant proposed, comprises 20 in. steam-driven, and 12 in. motor-driven centrifugal pumps with condensing plant.

The boiler house will contain four batteries of six water-tube boilers each, the latter each having an evaporative capacity of 24,000 lbs. of steam per hour. Automatic coal and ash conveying plants are proposed, and two steam-driven feed pump installations will be situated in the centre of the boiler house. The economiser will be divided into four sections and contain 1,280 tubes. It is proposed to erect an additional coal store on the bank of the canal basin capable of holding another 3,000 tons, and the system of conveyors may eventually be duplicated.

In connection with the three sub-station equipments, 13 sets of transforming apparatus, each having a capacity of 300 KW. and including rotary converters, stationary transformers, switchgear and batteries are provided for. In connection with the cable work, some 22 miles of H.T., 20 miles of traction, 18 miles of telephone, and six miles of L.T. lighting trunk mains are estimated for. This section of the work is a first instalment (*i.e.*, 8,500 KW.), and the cost is estimated at £441,142.

The Committee will have recourse to its reserve fund now standing at £26,394, in the event of there being a deficiency during the first year or two of working of the new scheme—but the tramways department is regarded as an assured customer, which will greatly help to cover any excessive charges.

On the 12th inst. the City Council adopted the report of the Electric Supply Committee, asking the L.G.B. to cancel the balance of £167,776 of a previous loan, and to sanction the borrowing of £441,142, for the work outlined above.

Blaydon.—The U.D.C. has declined to accept either the offer of the Priestman Power Co., or that of the Durham Electrical Power Distribution Co., to supply energy for electric lighting. It was stated that the terms submitted made the scheme impracticable.

Brighton.—The T.C. on April 7th decided to apply for a loan of £6,000 for the purchase of motors for hiring out purposes.

Cheltenham.—The T.C. has adopted the recommendation of its E.L. Committee that the price of energy for public lighting be increased from 2·27d. per unit to 3d. This will increase the income per annum by £2,532. It was also decided to inform the tramway company that a revision of the charge of 1·9d. per unit up to 100,000 is contemplated.

Chepstow.—A private electric lighting plant recently installed by Messrs. J. & G. Griffiths, the machinery for which was supplied by the India-rubber Co., was opened last week.

Crewe.—The Corporation E.L. Committee has fixed the price of energy for motive purposes as under:—First 100 units per quarter, 3d. per unit; next 100, 2½d.; 300 units per quarter, 2d.; all over 500, 1½d. The electrical engineer has been asked to state what the revenue will be on the rebate system, if the charge for energy for lighting is reduced from 6d. and 3d. to 6d. and 2½d.

Derby.—The amount of capital expenditure required for the current year is estimated at £6,500, made up as follows:—£3,000 for mains, £600 for services, £1,800 for motors for hire, £60 for the extension of the switchboard, £400 for meters, £40 for telephones, and £600 for contingencies, which sum has been granted; it was decided that the price for energy under the sliding scale system be fixed at 5d. per unit instead of 5½d.

Dorking.—The battery of 260 cells recently installed at the Dorking Electricity Supply Co.'s works, and mentioned in our last issue, is of the D.P. Battery Co.'s LH type, 21 plates.

Durham County.—The C.C. is at present collecting data preparatory to the full consideration of a proposal which has been laid before it to provide a county scheme of electrical supply. It is proposed that the water power in the county be utilised, and the various urban and rural councils have been asked to express their views. On the 9th inst., a conference was held at Durham in regard to the scheme, and, after discussion, resolutions were adopted urging local authorities not to enter into any arrangement with private companies for the supply of energy for lighting or power, or the laying of tramways, until the C.C. Committee had reported. A further resolution urging the C.C. to endeavour to arrange a conference of local authorities with a view to the formation of a scheme was also passed.

France.—A scheme is projected for the installation of an electric power plant on the Upper Roza Valley. The existing gas and electric power company which supplies the district, has the monopoly until 1913; it is stated that the new syndicate will begin operations by supplying energy to Mentone.

Glastonbury.—A provisional order for the lighting of the town by electricity has been granted by the B. of T.

Gorton.—The U.D.C., through its Electricity Committee, has come to an arrangement with the Manchester Corporation whereby its E.L. order will be handed over to the Corporation on a lease for 21 years, the Corporation to pay the sum of £500. The B. of T. had deferred consideration of revoking the order until June of this year, threatening, unless the Council took some steps to fulfil its obligations, not to allow it to remain in force.

Heckmondwike.—At the U.D.C. meeting on Monday last the Electricity Committee reported that it had again considered the minute referred back to it at the previous meeting, and unanimously recommended the Council to proceed with the additions to the generating plant, the cost being estimated at £5,000.

Hornsey.—The L.G.B. has sanctioned the borrowing of £37,333 by the T.C. for electric lighting purposes.

Hove.—The T.C. is negotiating with the Brighton Corporation and the Hove E.L. Co. for a supply of energy in bulk for lighting Aldrington.

Huddersfield.—A deputation of the Chamber of Trades has waited upon the Electricity Committee, asking for a reduction in the price of electricity. It was stated that a reduction would be made as soon as possible.

India.—On March 14th the Lieut.-Governor performed the ceremony of starting the engines in the new electrical power house at the Sibpore Engineering College. The plant comprises two Cornish multitubular boilers by Messrs. Marshall, Sons & Co., each of about 60 H.P., and working at 140 lbs. pressure, together with Worthington pumps and Körting injector. Two Marshall horizontal compound condensing engines with cylinders 8 in. and 12¾ × 14 in., working at a speed of 155 r.p.m.; these are belt-coupled to two Brown-Boveri alternators, 3 ph. 25 cycles, running at 500 r.p.m., with a capacity of 50 KW. each at 240 volts. The switchboard is of the same company's make. Four feeders are provided, three going to the workshops and one to an Oerlikon 45-H P. motor-generator. This latter machine is to be used for charging accumulators and for supplying direct current at 115 volts for lighting purposes, &c. The workshop electric motors range in size from 10 to 20 H.P., and have been supplied by the Oerlikon Co., the British Westinghouse Co., and Messrs. Brown, Boveri & Co.

Inverness.—The B. of T. has given its approval to the scheme for the electric lighting of the burgh.

Keynsham.—The Council has passed a resolution giving consent to the application for a prov. order made by the Keynsham E.L. Co.

Kildare.—The Local Government Board has sanctioned a loan of £3,300 for the purpose of lighting the town by electricity.

London.—ISLINGTON.—The Finance Committee of the B.C. has approved of the following estimates:—Mains and transformers, £215; dividing arc circuits in Upper Holloway and Caledonian Road districts into sections, £285; service lines, including meters, &c., during half-year ending Michaelmas, 1904, £1,520.

MARYLEBONE.—The B.C. has resolved not to execute the work of wiring on private property beyond the meters, except through a contractor.

Louth (Lincolnshire).—The T.C. has decided to enter into an agreement with the National Electric Construction Co., for supplying electric light and power in the town, subject to the consent of the L.G.B. being obtained to borrow a sum not exceeding £17,000 for carrying out the work.

Ludlow.—The T.C. has received an intimation from a private company notifying its intention to apply for a prov. order for the E.L. of the town.

Macclesfield. — The Electricity Committee recommended the Council to invite offers for the leasing of its prov. order, but the T.C., in referring the matter back, asked the Committee to submit one of the schemes proposed by Messrs. Crompton and Co. and the Southern District Electricity Corporation to the Council for adoption.

Maidstone.—The T.C. has resolved to extend the E.L. mains in order to supply energy to the Sanatorium, at a cost of £480.

Manchester.—The Electricity Committee of the City Council has been considering a scheme for increasing the capacity of several of its generating stations. The Council will be asked, at its next meeting, to seek borrowing powers to the extent of £135,000, which will be needed to defray the cost of extensions and alterations at the station in Dickinson Street and at various supply stations, as well as of the laying of lighting and traction feeders in different parts of the city.

Margam.—A L.G.B. inquiry was held recently into the application of the U.D.C. for a loan of £15,000 for E.L. purposes. It was stated that the Council obtained a prov. order in 1898, and had entered into negotiations with the South Wales Electrical Power Distribution Co. for the supply of energy at 1½d. per unit. Opposition was offered on behalf of a firm who pay one-twelfth of the rates, on the ground that the scheme could not possibly pay.

Motherwell.—As an inducement for intending consumers of electricity to get their connections made during the summer months, the Electricity Department has agreed to give a supply of electricity free up till August 1st to those new consumers who become connected between May 1st and August 1st.

Northampton.—The R.D.C. has resolved to give its consent to the local E.L. Co. to supply energy to Dallington, Weston, Favell, and Duston, the maximum charge to be 7d. per unit.

Oldbury.—The U.D.C. has passed the plans of an electric power station proposed to be erected in the town by the B.E.T. Co.

Paisley.—Messrs. J. P. Coats, Ltd., have been granted permission by the Dean of Guild Court to erect an electricity generating station at Ferguslie Thread Works.

Shanklin (I.W.).—The U.D.C. has resolved to consider the question of purchasing, at some future date, the undertaking of the electric light company, in conjunction with Sandown U.D.C.

Southport.—The Electricity Committee of the Corporation has decided to hand over £2,000 in relief of the rates, the amount being the same as last year.

Spain.—Application has been made for a concession to establish and work an electricity works at Medinaceli (Province of Soria).

Stamford.—The T.C. has invited the Urban Electric Supply Co. to submit a scheme for public lighting by electricity.

Stockport.—A uniform charge of 4d. per unit will in future be made for electricity for lighting purposes. The change will, it is said, benefit 95 per cent. of the consumers.

Wakefield.—The price of energy for lighting has been reduced by the T.C. to 4d. per unit as from July 1st, and meter rents abolished.

Wimbledon.—A L.G.B. inquiry was held last week into the application by the T.C. for powers to borrow £550 for installing 36 arc lamps in the main thoroughfares.

Wisbech.—The Town Council has sealed the contract with the National Electric Construction Co. for the establishment of electricity works in the town, and it has been decided to apply for a loan of £25,000 in connection with the scheme. Messrs. Robt. Hammond & Sons were appointed consulting engineers to the Council.

Worsley.—The U.D.C. has under consideration the proposal of the Lancashire Electric Power Co. to supply electricity for lighting purposes to the town, under an arrangement for distribution by Edmundson's Electricity Corporation. Modifications in the maximum charges proposed to be inserted in the agreement have been asked for.

Worthing.—The T.C. has applied to the L.G.B. for a loan of £1,500 for the provision of E.L. mains, meters, house services, &c.

TRAMWAY AND RAILWAY NOTES.

Adelaide (South Australia).—The Government have announced their intention of exercising their powers to purchase the horse tram lines of Adelaide and its suburbs and to equip them for electric traction. The lines cover some 50 miles of streets, and about half the total mileage—that owned by the Adelaide and Suburban Tramway Co.—becomes purchasable by the end of the present year. The remaining lines are worked by some half-dozen small companies, and the right to take over these will accrue at various times within the next few years. A private Act was obtained by a company in 1901, for the acquisition of the lines and their conversion, but owing to the tightness of the financial world, and to the stringent clauses inserted in the Act as to payments for right of way and fares to be levied, the necessary capital could not be raised and the company's powers have been allowed to lapse. There has also been considerable talk of a "municipal trust" being formed between the Corporation of Adelaide and the Municipal and District Councils of the suburbs—some 12 or 15 in number—to take over and electrify the lines; but it has been found impossible to arrange mutually satisfactory conditions between the diverse interests, and it was at the instigation of the municipal bodies that the Government have decided to avail themselves of their right of purchase. As announced, the intention is to take over each line as it falls in and to invite tenders for the complete electrification of the various lines. The general feeling is antagonistic to the State operating the lines after reconstruction, and it is, therefore, probable that a lease will be granted—either to the "Municipal Trust" or to a private company—if satisfactory terms can be arranged.

Automatic Signalling on the N.E. Railway.—The automatic signalling apparatus, which has been installed on the main line between Alne and Thirsk by the Hall Automatic Signalling Co. was put in service on Sunday last. The *Times* states that a special train conveying the principal officials of the line went over the portion of the line thus equipped on Sunday. For the present the automatic service will be worked concurrently with the existing mechanical signals, and a man will be stationed at each automatic semaphore to report on its working. The patent automatic signalling apparatus, which has been devised by Mr. W. L. Raven, assistant mechanical engineer of the North-Eastern Railway Co., has been adapted to each signal.

Belfast.—The broken off negotiations between the Belfast Corporation and the Belfast Street Tramways Co. have been renewed. The Law Committee of the Corporation discussed privately the situation on Monday last, and recommended that the provision of payment of interest at 4½ per cent. should be agreed to, and that the debentures (which have a liability of 3½ per cent.) should be taken over by the Corporation. A special meeting of the Corporation will be held to consider the modified terms.

Birkenhead.—The profit on the working of the tramways for the last financial year was £7,500, as against £3,700 in the previous year. The cost of working per car-mile has been reduced from 9·71d. to 9·58d. The number of passengers carried was 11,327,932, against 10,390,985. The receipts were £54,660, against £51,067. The accounts of the electricity department show a surplus of £1,500, which will be carried to the reserve fund.

Black Country.—To meet tramway requirements in the Black Country, two power stations are to be erected—one at Smethwick, and the other at Oldbury—at an estimated outlay of over £100,000. The plant, it is anticipated, will cost £50,000, and will be put down with the view to the generation of electricity for use on the lines running between Birmingham and Dudley, through Smethwick, as well as for public and private lighting purposes. A tramway is shortly to be constructed between Old Hill and Blackheath, at a cost of £30,000.

Brighton.—Reports have been circulated in the local papers to the effect that there has been a loss of £6,000 as a result of the year's working of the tramways up to March 31st, but up to the present no official figures have been brought forward. Large numbers of men are engaged in laying the lines in Dyke Road, and considerable progress has been made with the work since the start. The whole of the work is being carried out by the Corporation direct, without the assistance of contractors, and the result is awaited with considerable interest.

Bury (Lancs.).—The Rochdale Road section of the borough tramways (which are being converted from steam to electrical traction) will be completed by the end of the present week, and opened for traffic without delay. The Limefield section is to be begun immediately.

Crewe.—The T.C. some time ago decided to promote an electric tramway scheme of its own, and withdrew its support from a private company. It had been arranged that application should be made in May for an order, but the *Liverpool Courier* says that, on account of trade depression in the borough, the railway workmen being on short time, the Committee has decided to abandon the scheme for the present.

Derby.—Progress is now being made with the installation of the electric trams in Derby, and on two of the routes the overhead wires are practically complete. The work of laying the rails, however, has been considerably hampered through the belated delivery of material. This delay, it was explained by Alderman Butterworth, J.P., at the meeting of the Council last week, was really caused by the order in the first place having been placed with a Belgium firm. The fish plates had been sent from Belgium, but they had had to be returned, and the contractors were now awaiting the making of them by an English firm. A large consignment was expected in a few days, and the work would be pushed forward as rapidly as possible, so that the roads at present closed for traffic could be opened.

Dudley.—Our Wolverhampton correspondent says that overhead wire accidents have been so frequent on the Dudley line that Councillor A. H. Hillman has given notice of his intention to move the following resolution at the next meeting of the Council:—

This Council, viewing with considerable anxiety the accidents that have occurred in the public streets in connection with the electric wires of the tramway companies, apply to the Board of Trade to give the matter their attention, with a view of securing efficient supervision of the overhead equipment of such tramways, that the safety of the public may be secured.

Germany.—An electrical trolley motor omnibus service is about to be started between Wermelskerchen and Dhünn.

Glasgow.—It has been remitted to the convener and the sub-convener of the Tramway Committee to co-operate with the other municipalities owning and operating tramways in any action which they may think necessary to take with regard to the question of compulsory running powers being given to private tramways companies over public systems.

The Tramways Committee has accepted an offer by the Electric and General Assurance, Ltd., who undertake for one year the third party risks for a premium of £14,000, and, in addition to the security offered by them, to have their policy covered at Lloyd's, the limit for any one accident to be £2,500, and the indemnity for the year to be £25,000.

Hull.—The Corporation Tramways Committee on Friday decided to reduce the forfeiture of £896 10s., incurred by the Westinghouse Co. and Messrs. G. F. Milne & Co., contractors for the car bodies, incurred by the non-delivery of cars within the specified time, to £500, subject to certain defects in the roof blinds of the cars being remedied.

Leeds.—The report for the financial year respecting the working of the city tramways says that the gross car receipts have amounted to £277,655, as against £262,343 in the previous year, an increase of £15,221 on the receipts of a year which itself showed an increase of nearly £42,000 on its predecessor. The car-mileage amounted to 6,091,437 miles, as against 5,773,651 miles run in the previous year, an increase of 317,786 miles. There have been practically no new lines operated during the year. The total receipts per car-mile have been 10·94d. against 10·90d. The passengers carried were 60,739,234 as against 57,239,779, an increase of 3,499,455 on the year. The entire population of the city has been carried no less than 136 times in the year. The other side of the balance-sheet will not be presented for some weeks yet, but it is unlikely that there will be any such sum as £62,000 available again to eke out a difficult situation in the city's financial affairs, for the year has been a somewhat expensive one. A great many routes have been relaid, a number of new cars have been provided, and in many ways expenses have been fairly heavy. In addition, there are many extensions in contemplation, for which funds will have to be provided, so that considerable inroads will have to be made on the total receipts.

Mansfield.—Notice has been given on behalf of the Mansfield and district light railway promoters that it is proposed to forthwith proceed with the work of constructing electric tramways within the borough. The scheme is divided into eight sections, but the promoters intend at present only to deal with three.

Nottingham.—The Tramways Committee has prepared a scheme which is designed to link up the whole of the eastern part of the city with the network of tramways in the Great Market place, and after it has been adopted by the City Council, a Bill will be presented in the next session of Parliament. The scheme is estimated to cost about £75,000. During the two years the electric trams have been running, they have carried nearly fifty-three million passengers.

Southport—Liverpool Electric Railway.—It had been arranged that 20 trains should run between Liverpool, Southport, and Crossens, on Sunday last, on the new electric railway, and that all steam trains should be withdrawn between Liverpool and Southport. Unfortunately, however, owing to a mishap at the chief electric power station at Formby the service of electric trains had to be temporarily discontinued. On Monday (11th) the steam trains were again put on full-service.

Spen Valley.—There was considerable interference a few months ago with the working of the Spen Valley tramways, owing to a dispute between the B.E.T. Co. and the Heckmondwike Urban District Council respecting the rate of payment for energy which is supplied by the Council. The agreement provided that in the event of the maximum demand by the company exceeding a stipulated amount there should be an increase in the price per unit to recompense the Council for the additional machinery that would be necessary to give an adequate supply. When it was discovered that the maximum demand was exceeding the quantity the Council was called upon to supply at the rate the company were paying, an increase in the price was asked for, but the company declined to pay it, and this led to the stoppage of cars during heavy traffic. The District Council agreed to make a concession from the full price stipulated for under such circumstances, but the company failed to come to terms. The inconvenience therefore continued until it was arranged that a supply equal to the demand should be provided on the understanding that payment for it should be in accordance with the settlement arrived at afterwards. The company referred the matter to the Board of Trade, but the latter have replied to the effect that they cannot interfere with the agreement made between the two bodies.

Wednesbury.—The Corporation has received from the B. of T. copy of an application made by the South Staffordshire Tramways (Lessee) Co. for a renewal of the steam license expiring on the 24th inst. Having regard to the fact that, under terms signed by Mr. Garcke and Mr. Lycett on behalf of the company in April, 1903, it was agreed that the electrical equipment of the lines in Wednesbury should be taken in hand forthwith, it has been decided to ask the B. of T. to refuse their sanction to any further license for the use of steam traction in the borough.

West Bromwich.—The capital accounts in respect of the purchase and reconstruction of the electrical tramways in the borough have now been closed. They show that £4,638, borrowed in excess of the actual expenditure, has been transferred to the loans fund in reduction of the annual instalments for the redemption of the tramways stock debt.

Worcester.—The Tramways Co. has arrived at an agreement with the T.C. relative to the Corporation's claim for the cost of energy not used, owing to the tramways not being completed, and a certain sum will be paid in settlement of the claim.

TELEGRAPH AND TELEPHONE NOTES.

Anglo-Continental Telephony.—On Monday, the new service of the Post Office trunk telephones between Liverpool, Manchester and other provincial towns, and Paris and other towns in France, was opened. The charge for a conversation of three minutes is 8s., the same charge being made for a second three minutes. Messages from persons in French towns were heard very distinctly in Liverpool and other towns on Monday.

Brighton Telephones.—The Telephone Committee of the T.C. has brought in a report that, owing to the number of applications received, many of the cables are fully connected up, and as a result it recommends the Council to sanction the sum of £4,200 for additional ducts and cables to relieve the Lewes Road and Beaconsfield Road districts; the manager, Mr. Barnes, stating that, owing to the lack of sufficient accommodation, he had been unable to connect up the fire alarm system. Up to the present, 950 subscribers are connected up, and about 800 are still awaiting connection.

Congo Free State.—The Congo Free State Budget for 1904 states that a sum of £18,000 has been devoted to the extension of the telegraph and telephone services in the territory named.

Glasgow Telephones.—A Committee of the T.C. has been appointed to co-operate with Hull, Swansea, Brighton and Portsmouth, and to take such action as may be necessary in connection with the proposed acquisition by the Government of the undertaking of the National Telephone Co. It has been agreed to apply to the Postmaster-General for approval of party line rates, and to inquire on what terms the Postmaster-General will be prepared to issue a licence for electrophones.

The T.C. has accepted an offer by the Ericsson Bell Telephone Co. for 1,000 wall telephones and 250 table telephones.

A memorial has been sent to the Secretary for Scotland in connection with the applications by the T.C. for money for telephone purposes. It suggests that before considering any application for further sums, an inquiry should be instituted by some unbiassed expert into the method of telephone construction, the working and the accounting of the telephone venture from the beginning, the obsolescence of the system; whether the accounts are kept in terms of the Acts of Parliament, and in a way simple enough to disclose to the ordinary ratepayer the true state of affairs; whether adequate allowance is being made for depreciation, maintenance and repayment of debt, and whether telephones have been supplied to users at under cost price, and what would be a paying price. It is pointed out that the capital outlay by the Corporation at May 31st, 1903, amounted to £270,938, averaging £33 per line, including spare plant, as against the estimate of £18 16s. The total revenue for the year ending on that date was £35,019. Up till the end of last May the memorialists remark that no depreciation had been written off plant, &c. The telephone auditors, in their report to the Corporation of August 10th, 1903, on the accounts, called special attention to this. They also pointed out that no portion of the sum of £16,474 standing at the debit of preliminary and general expenses in the capital account had been written off out of revenue. From the figures furnished, and from internal evidence in the accounts themselves, it was obvious that the surplus of £1,694 on the year's operations ended May 31st, 1903, existed only on paper, and that on a sound accounting a large deficit would be the result. The memorialists conclude by saying that inquiry would disclose that the Corporation telephone enterprise had been wrongly conceived and badly executed, was being carried on at a serious loss, and could never be made to pay; and that, instead of sanctioning further sums being borrowed and hopelessly sunk, the enterprise should, for public convenience, be linked with the National Telephone system, pending the taking over of both enterprises by the Government.

New York.—A Press telegram from New York says that a fire which occurred in the new rapid transit subway in Broadway fused between 5,000 and 6,000 telegraph and telephone wires and cut off all communication with the Stock Exchange and other large business offices of the city.

Municipal Telephone Conference.—On 11th inst., at the Westminster Palace Hotel, a conference was held of representatives of the corporations owning and working telephones, to consider what action should be taken by them in view of the proposal of the Government to secure the undertaking of the National Telephone Co. Sir John Primrose, Lord Provost of Glasgow, presided, and among those present were representatives from Glasgow, Hull, Guernsey, Brighton, and Swansea. According to the daily press reports the chairman, in his opening remarks, said it was desirable that the corporations should at once make a representation to the Postmaster-General to secure that, before the negotiations with the National Telephone Co. proceeded too far, the corporations should be afforded an opportunity of being fully heard on the subject, in so far as it affected their interests. The conference was strongly of opinion that all local authorities should have the opportunity, if they desired to do so, to work local telephones, and that the Government should be left to work and perfect the trunk system. After a full discussion the meeting adjourned, in order that the representatives might report to their respective councils. Meantime, an executive committee was appointed to watch over the interests of the municipalities in the light of the discussion.

The *Times* says that on Tuesday the representatives of the municipal corporations were received by the secretary to the Post Office, who assured them that an opportunity would be given them of placing their views before the Postmaster-General. One of the proposals of the municipal corporations is, that steps should be taken to secure that, in the event of Parliament's appointing a committee to consider the negotiations between the Postmaster-General and the National Telephone Co., the municipal corporations should be enabled to lead evidence before that committee.

Portsmouth Telephones.—The decision of the L.G.B. to veto a portion of the loan applied for by the Telephone Committee of the T.C. has been the subject of much comment. At a meeting of the Committee Councillor W. T. Dittman, J.P. (chairman), reported the receipt of a letter from Mr. Bennett, the consulting engineer, stating that the Glasgow Corporation, on March 11th, sent an application to the Secretary of State for Scotland, as head of the Scottish L.G.B., for an additional loan of £50,000 for telephone purposes, and on March 16th received a reply sanctioning the loan without comment. Mr. Bennett asked that this might be made known as illustrative of the methods of the English and Scottish L.G.B's. It was decided to draw the attention of the local M.P's. to the matter.

The Telegraph Cable Export Trade.—So far this year the export trade of this country in telegraph cables and apparatus connected therewith has been very quiet, the shipments during last month only amounting to £27,041 as against £230,280 in the same month a year ago. The returns for the three months ending with March, too, show a falling off, the shipments having amounted to £243,836 as contrasted with £341,033 in the corresponding quarter of last year, and £749,355 in the first three months of 1902.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Cayenne-Pinheiro	Aug. 18, 1902	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 23, 1902	
Tourane-Amoy	Nov. 10, 1903	
Tarifa-Tangier	Jan. 18, 1904	
St. Jacques-Haiphong	March 7, 1904	April 6, 1904
Closed { Nagasaki-Vladivostock	Feb. 15, 1904	
Closed { Port Arthur-Chefu	Feb. 18, 1304	
Foochow-Formosa	Feb. 11, 1904	
Dakar-Conakry	April 11, 1904	
Landlines.		
Seoul-Masampo	Feb. 13, 1904	
Seoul-Gensan	Feb. 13, 1904	
Anju-Ping-Yang	Feb. 25, 1904	
Ninguta-Vladivostock	March 2, 1904	
Moulmein-Bangkok	April 9, 1904	April 9, 1904
Saigon-Bangkok	April 12, 1904	

Telephony in Portugal.—It is stated that the telephone line erected between Lisbon and Oporto by the Anglo-Portuguese Co. for the Portuguese Government has been completed, and was to be open to the public from Monday last.

Underground Telegraphs.—The close of the financial year has seen the completion of the London to Manchester underground telegraphs. The lines from Stafford to Warrington have been joined up to the underground line between Manchester and Liverpool, thus providing a through service between those cities and London, which, it is hoped, will prevent the recurrence of such a disaster as that of three years ago, when the metropolis was completely shut off from the North for several days successively. The policy of the Department is to place the wires in all exposed sections beneath the surface. With regard to the Scottish service, it is understood that wayleaves have been secured as far as Beattock, in Dumfries-shire, from which place separate cables will diverge to Edinburgh and Glasgow respectively, and eventually to towns further North. The Manchester line is being extended to Leeds and other Yorkshire towns.

Address Wanted.—A correspondent wants to know the present address of Mr. Ronald A. Scott, formerly of The Elms, Acton Hill, London, W. If any of our readers can furnish the information, will he kindly forward it to the publishers of the Elec. Rev.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—April 30th. Condensing plant, pump and piping. See "Official Notices" to-day.

Barrow-in-Furness.—April 20th. Condensing plant, electrically-driven pump, &c. See "Official Notices" April 1st.

Belgium.—April 26th. The Board of Trade have received through the Foreign Office a despatch stating that the Municipality of Antwerp invites tenders for the electric lighting of the Flemish Theatre in that town. The deposit payable on each tender is £200. A copy of the specification may be seen at the Commercial Intelligence Branch of the Board of Trade.

Chili.—June 28th. Electric lighting of the city of Punta Arenas (Straits of Magellan). See this column for February 19th.

Dublin.—May 9th. Steam three-phase extra high-pressure set (1,000 to 1,500-kw.), piping and switchboard. See "Official Notices" to-day.

Edinburgh. — April 23rd. Switchboard extension, piping. See "Official Notices" March 25th.

Epsom.—April 18th. Feeder and distributor cables. See "Official Notices" April 8th.

Govan.—April 26th. Stores, &c., for the Electricity Department. See "Official Notices" to-day.

G.W. Railway.—April 26th. Four 200-kw. and ten 400-kw. motor-generators, four cooling towers, cranes, and coal and ash conveying plant, for Park Royal generating station and various sub-stations. See "Official Notices" April 1st.

Grimsby.—April 18th. Electrical installation at the Alderman Dobson Schools. See "Official Notices" April 1st.

Hammersmith.—May 18th. Two 1,500-kw. steam turbines or low-speed engine generating sets, with condensers; boilers and superheaters. See "Official Notices" to-day.

Heckmondwike.—April 26th. Feed pumps, steam traction generator, boiler, switchgear, induced draught apparatus, and underground feeders. See "Official Notices" to-day.

Italy.—August 18th. Tenders are being invited until August 18th next by the municipal authorities of Amelia (province of Umbria) for the electric lighting of the town.

Kilmarnock.—May 17th. Permanent way work. See "Official Notices" to-day.

L.C.C.—May 17th. Extra high-pressure three-phase board, low-pressure combined direct and three phase ditto, sub-station and transformer boards for Greenwich power station. See our "Official Notices" to-day for particulars.

Manchester.—April 28th. 90-B.H.P. water-turbine, dynamo, electric motors, overhead equipment for railway track, switchboard, &c., for the Waterworks Committee. See "Official Notices" to-day.

Melbourne.—May 13th. One 750-kw. direct-current steam dynamo. See "Official Notices" March 18th.

Natal.—May 9th. Electric telpherage system for Bonded Warehouse. See "Official Notices" March 18th.

Spain.—April 18th. Tenders are being invited until the 18th inst. by the Spanish Post and Telegraph Authorities for the establishment and working of a telephone exchange at Martorell (province of Barcelona) with sub-stations at Monistrol de Monserrat, Capaellades, Igulada and Esparraguera. Tenders are to be sent to La Direccion General de Correos y Telegrafos, Carretas, 10, Madrid, whence particulars may be obtained.

Spain.—April 24th. The Municipal Authorities of Talevera de la Reina (Toledo province) are inviting tenders until the 24th inst. for the concession for the electric lighting of the town during a period of 6½ years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Talevera de la Reina (Toledo.)

Rhyl.—April 18th. Carbons, meters, oils for the electricity department. See "Official Notices" April 1st.

Royton and Crompton.—April 30th. Permanent way, &c. "Official Notices" April 8th.

Tynemouth. — April 22nd. Meters, indicators, and motor hiring for the Corporation. See two "Official Notices" March 25th.

Wallasey.—April 27th. Stores for the Electricity Department. See "Official Notices" to-day.

Wallasey.—May 7th. Condensing plant. See "Official Notices" to-day.

Westminster.—April 18th. High and low-pressure switchboards for the Westminster Electric Supply Corporation. See "Official Notices" March 18th.

CLOSED.

Auckland.—The Auckland Electric Tramways Co. has placed a contract with the the Brush Electrical Engineering Co. for a 600-KW. Brush three-crank triple-expansion engine and traction dynamo.

Canterbury.—The T.C. has accepted the tender of Messrs. Pritchetts & Gold, of Feltham, for a new battery of accumulators at £565, the battery to be maintained at 90 per cent. of the original capacity for 10 years at £80 per year.

Dewsbury.—The T.C. has accepted the tender of the Tudor Accumulator Co. for the renewal of one side of the battery at the electricity works.

Fareham.—The U.D.C. has accepted the tender of Messrs. J. Fraser & Son, for the supply of a boiler and fittings at the E.L. works, at £360.

France.—The French Post and Telegraphs Authorities in Paris have just placed contracts as follows:—La Compagnie des Trefileries du Havre, 120 tons of high conductivity copper wire, 4 mm. diameter; La Compagnie Française des Métaux, Paris, 40 tons, ditto; La Compagnie Générale d'Electricité, Paris, 40 tons, ditto.

Great Central Railway.—A contract for lamps for the next 12 months has been placed with the "Sunbeam" Lamp Co.

Hackney.—The Guardians have accepted the tender of Messrs. Jackson Bros. (£570) for the electric lighting of the new casual wards.

Hereford.—The following tenders in connection with the Asylum have been accepted by the T.C.:—

W. J. Fryer & Co., rewiring	£2,187	0	
Custodis Chimney Construction Co., Ltd., chimney shaft	229	0	
E. Danks & Co., boiler	252	10	

Hull.—The T.C. has accepted the tender of the International Electrical Co., for the supply of a switchboard for the Trippett Telephone Exchange, and that of the Hart Accumulator Co. for accumulators.

India Office.—The Secretary of State for India has placed a contract with the Sir Hiram Maxim Electrical and Engineering Co. for high voltage lamps.

Newport (Mon.).—The Electricity and Tramways Committee has accepted tenders for materials required in connection with the overhead equipment of Stow Hill tramways, and for other materials necessary for general electricity supply purposes. Items 1, 2, 3 and a portion of 7 are for the latter, the complete list being as follows:—

(1) Booster, and (2) battery milking booster, Messrs. Johnson & Phillips, Ltd., £418 6s.
(3) Switchboards and instruments, Messrs. Alger & Sons, Newport, £463.
(4) Poles, brackets, &c., British Thomson-Houston Co., £402 11s.
(5) Overhead material, Messrs. R. W. Blackwell & Co., £94.
(6) Section pillars, British Electrical Equipment Co., £37.
(7) Cables, Messrs. Johnson & Phillips, Ltd., £3,602.
(8) Trolley wire, British Electrical Equipment Co., £140 12s.

The tender of the Glasgow Numeral Co. for the supply of 5,000,000 tramway tickets at the price of 2¾d. per 1,000, the company retaining the advertising rights on the backs of the tickets, was also accepted.

Tenders for the supply of 270 tons of rails and 7½ tons of fishplates required for Stow Hill tramways have been opened. The two lowest tenders were from Messrs. Alexander Renney & Co., of London; their lower price was for rails at the rate of £4 12s. per ton, and for fishplates at £5 17s. per ton, or a total of £1,284 8s. 3d. These rails are, however, in 40 ft. lengths. Their higher tender was for rails 45 ft. in length at £5 7s. per ton, and fishplates £5 17s. per ton, making a total of £1,486 18s. Messrs. Renney & Co. stated that the rails referred to in their former tender were over-rolled in connection with a previous order. It was resolved that the borough engineer be instructed to inspect the rails tendered for at the lower price, and if they be satisfactory, that the tender be accepted, but if not satisfactory the tender at the price of £1,486 18s. 3d. be accepted, and in the latter event the borough engineer be authorised to appoint an inspector to inspect the rails in course of milling.

War Office.—The Army Council of the War Office has placed an order with Messrs. Bruce Peebles & Co., Ltd., for the motor equipment of the Small Arms Factory, Enfield Dock. The contract will comprise about 1,000 H.P. in motors.

Warrington.—The Corporation has accepted the tender of the British Thomson-Houston Co., Ltd., for one year's supply of electrical motors.

FORTHCOMING EVENTS.

Tuesday, April 19th.—At 8 p.m. Institution of Civil Engineers. "Aerial Suspension Cableways," by Mr. J. MacDonald Henderson.

Wednesday, April 20th.—At 7.30 p.m. Institution of Electrical Engineers. "Armature Reactions in Alternators; with some notes on the Running of Synchronous Motors," by Mr. H. W. Taylor.

At 7.30 p.m. Institution of Electrical Engineers (Birmingham). "Some Properties of Alternators Under Various Conditions of Load," by Mr. A. F. T. Atchison.

At 8 p.m. Society of Arts. "Motor Cars for Popular Use," by Mr. Mervyn O'Gorman.

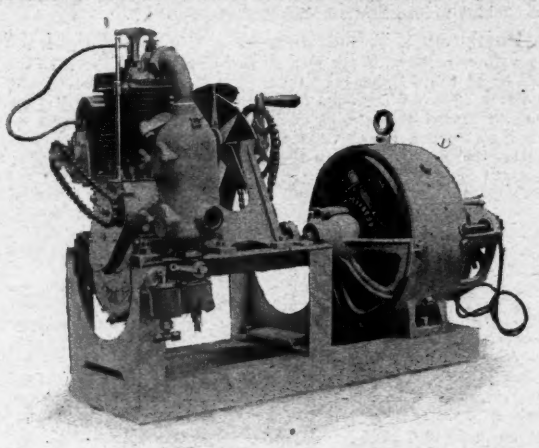
Thursday, April 21st.—At 5 p.m. Royal Institution. Prof. Dewar on "Dissociation." (Lecture II.)

At 8 p.m. Institution of Civil Engineers. "James Forrest" Lecture by Mr. D. Clerk on "Internal Combustion Motors."

Friday, April 22nd.—At 5 p.m. Physical Society Meeting.

NOTES.

Searchlight Plant for India.—The accompanying illustration shows a small portable electric light plant which was recently supplied to H.M. War Office by the Simms Manufacturing Co., Ltd. The plant is destined for India, and will be carried by mules. The plant, minus the dynamo, weighs only 98 lbs. The engine is a 3½-H.P. air-cooled Simms motor, with a specially-



SIMMS PORTABLE ELECTRIC LIGHTING SET.

designed petroleum carburettor, the engine starting and running on ordinary kerosene oil. We are informed that the motor during a continuous test ran six hours, and, although air-cooled by means of a fan, gave excellent results. The output is 20 amperes and 75 volts at 1,500 r.p.m. The plant is intended for searchlight purposes.

American Electro-chemical Society.—The following papers were down for reading at the meeting of this society, held on April 7th, 8th and 9th, at Washington:—

"Standard Cells," by Dr. F. A. Wolff.
"The Preparation of Materials for Clark and Weston Standard Cells," by Dr. H. S. Carhart and Dr. G. A. Hulett.
"Single Potentials of the Halogen Elements," by W. R. Mott.
"The Composition and Resolution of Voltages," by Dr. J. W. Richards.
"Molecular Conductivity," by C. J. Reed.
"Remarks on Prof. Richards's Theory of Heat of Neutralizations," as presented to the society, September 17th, 1903, by Gustaf M. Westman.
"The Energy of Ions," by Dr. L. A. Parsons.
"The Aluminum Electrolytic Condenser," by C. I. Zimmerman.
"Electrolytic Iron," by C. F. Burgess and Carl Hambuechen.
"The Economic Balance in Electrolytic Copper Refining," by Lawrence Addicks.
"A New Electrolytic Separation of Gold and Silver," by Herman Poole.
"Observations on the Preparation of Electrolytic White Lead," by C. F. Carrier, junior.
"The Relation between the Cost of Salt and the Cost of Power at a given Locality, and the Resulting Cost of Electrical Bleaching Liquor Produced," by Dr. W. H. Walker.
"A Relative Decimal Index for Electro-chemical Interests," by Adolph L. Voege.
"Notes on the Industrial Electrolysis of Water," by Mr. W. S. Landis.
"A Contribution to the Study of the Electric Arc," by Dr. Wm. S. Weedom.
"Electric Smelting Experiments for the Manufacture of Ferro-Nickel from Pyrrhotite," by Mr. Ernst A. Sjosted:.
"Some Experiences in Copper Precipitation," by Hermann Poole.
"The Relation of the Alternating Current to Osmotic Pressure," by W. H. Davis.
"Some Phenomena Observed in Connection with the Use of a Copper Voltameter," by Isaac Adams and Barry MacNutt.

The Institution Secretaryship.—Mr. George C. Lloyd, chief assistant to the secretary of the Iron and Steel Institute, has been appointed secretary of the Institution of Electrical Engineers. Mr. Percy F. Rowell, chief assistant to the late Mr. McMillan, has been appointed assistant secretary.

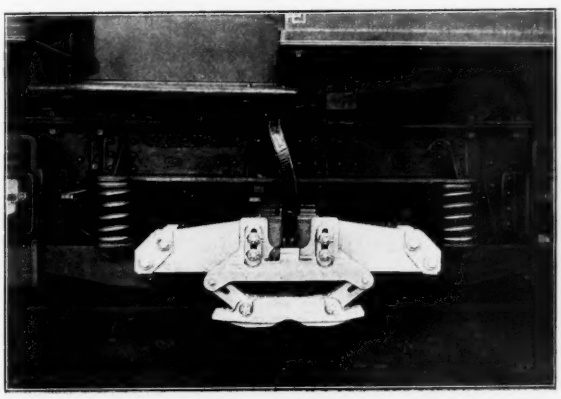
Obituary.—Our American exchanges recently recorded the death of Mr. William A. McGuire (of the McGuire Manufacturing Co., of Chicago), which occurred on February 29th at the age of 44 years.

(*Continued on page* 632.)

LIVERPOOL—SOUTHPORT AND CROSSENS ELECTRIC RAILWAY.

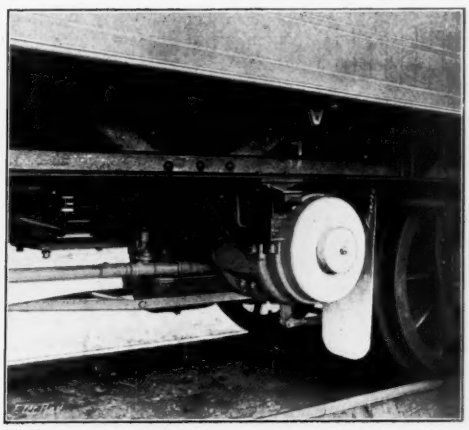
(*Concluded from page* 551.)

The current, as already stated, is collected by cast-steel slippers, on each side of the motor bogies. These slippers weigh about 90 lbs. each, and have so far given the greatest satisfaction. On straight runs of third rail there are thus four shoes collecting at one time. From the slippers, which are suspended by forged slotted links from a wooden beam carried on extensions on the bogie, a highly-flexible lead of special construction is carried to a fixed terminal, from which the main cables pass to the controller.



Collector Shoe.

The vacuum brake is used on the electric trains, thus making them available for service with the company's other rolling stock and locomotives at any time. The general arrangement of fittings and brake cylinders is similar to that already in use, but the steam ejector is replaced by a twin-cylinder geared vacuum pump driven by a 3-H.P. 600-volt motor, the usual ball valves on the brake cylinder are dispensed with, and an electrically actuated valve is substituted; the movement of the motorman's valve when the brake handle is placed in the "brake-off" position, lifts these valves along the train, procuring, if desired, an almost instantaneous release of the brake. Automatic electro-pneumatic regulators in the pump motor circuits maintain a constant vacuum in the vacuum reservoir.

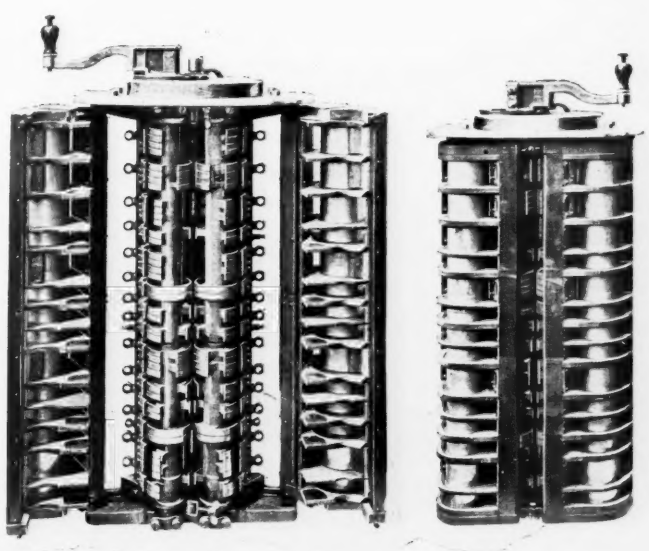


Vacuum-Brake Pump and Motor.

A large motor-car horn containing a reversed reed of special construction is used in place of a whistle, a connection to the vacuum reservoirs enabling the air for blowing it to be supplied from the atmosphere.

The motorman's compartment, in addition to the controller and switches for the main motors, contains a motorman's brake-valve, a vacuum gauge, a single-pole switch for starting the brake motors, and fuses for the pump motor and brake control circuits.

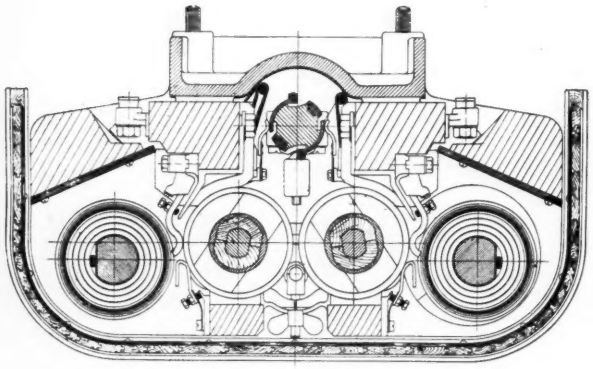
Interior of Driver's Cab.



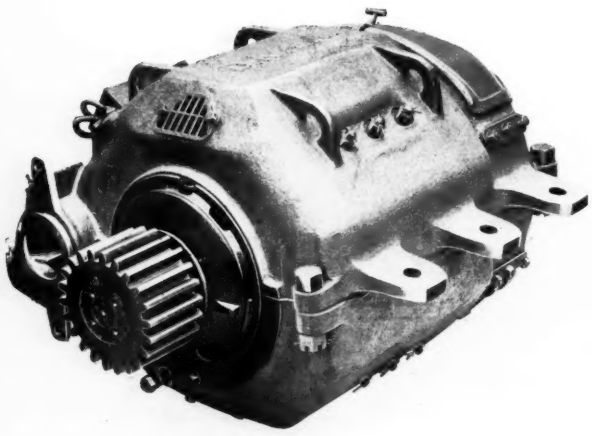
Controller, with Solenoid Blow-outs Open and Closed.

These compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with uralite. In addition to the cable troughs, in which the

cables are placed for conveying current to the motors and the equipment, being lined with uralite, the whole of the floor over the motors is covered with the same material and with thin steel plates. All the trains carry fire appliances,



Plan of Controller.



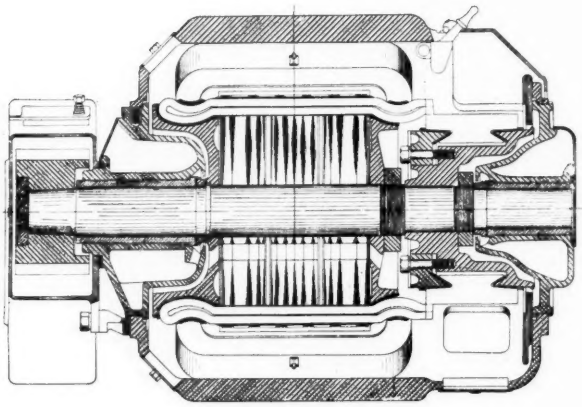
Dick, Kerr 150-h.p. Railway Motor.

and ample steps have been taken to ensure safety in this respect.

As has been already stated, there are eight motors on a complete train, which drive the axles through single reduction gear. They are of the Dick-Kerr 4 A railway type, rated to develop 150 B.H.P. at an armature speed of 470 revolutions per minute. The weight of the complete motor is 6,050 lbs., of the armature 1,920 lbs., and of the gear wheels and housing 500 lbs.

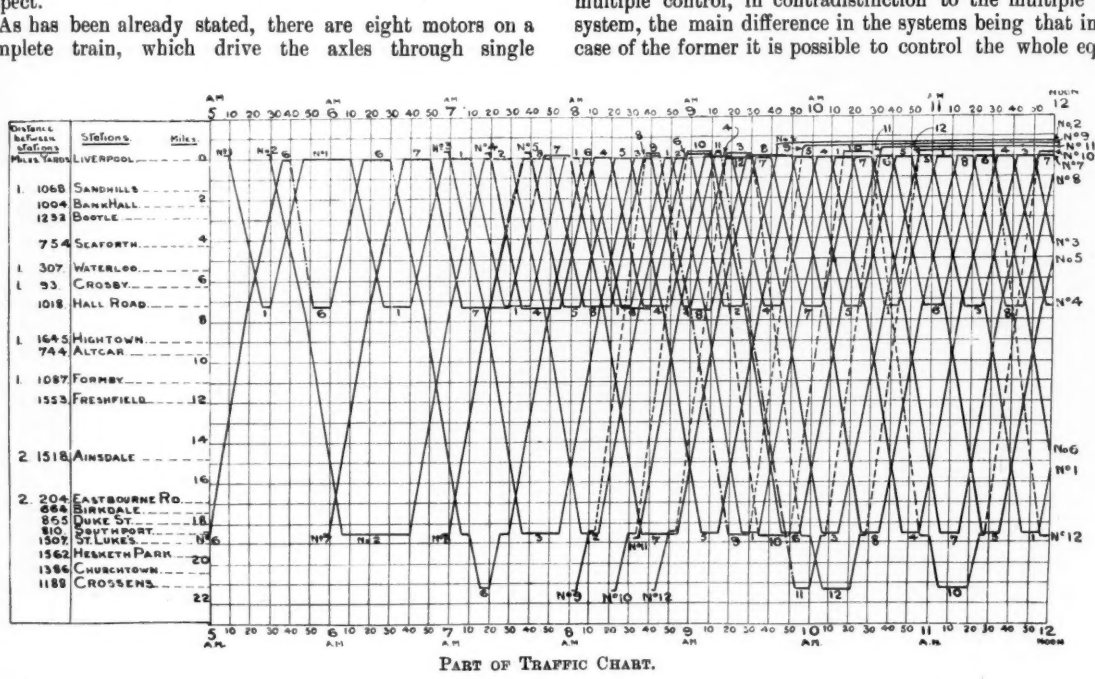
The conditions of performance which the motor has to fulfil, as regards both speed and high acceleration, have necessitated liberality in design, and in consequence they will bear considerable overloads for short periods with a moderate rise in temperature. The main features of the motor are similar to those of the standard traction type. The magnetic field is built up of steel shells, in which are four laminated steel poles, secured to the shells by bolts. The spools are built up of copper wire and asbestos ribbon, heavily taped over all, impregnated and baked. The core discs of the armature are of annealed magnetic steel, punched with keyways and air ducts, and are strung direct on the shaft. The windings are former-wound, and insulated with a special combination of mica. The commutators are built up of drop-forged copper bars insulated with pure mica, the whole being carried on a special hard micanite ring. The brushes are carried by a special bracket designed to give considerable adjustment, and the complete design of the motor is such that ready access is obtained to the brushes and the commutator. The brushes are of high-grade carbon, copper plated.

One of the most interesting features of the equipment is



Section of Motor.

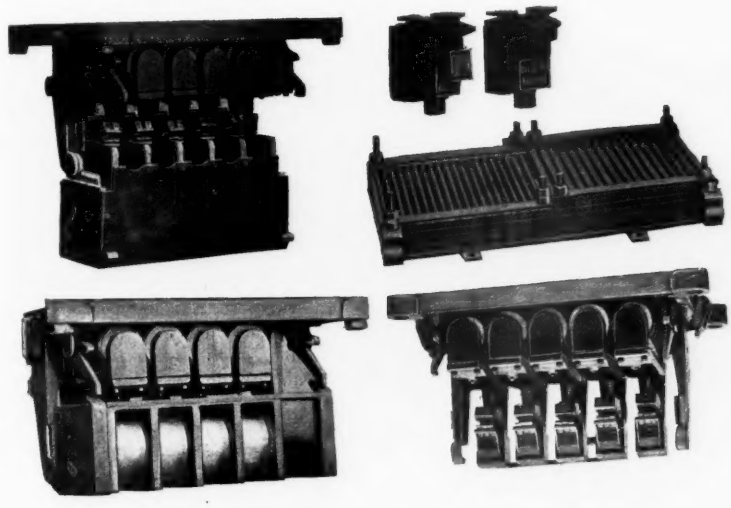
the method of control, which has been termed the direct-multiple control, in contradistinction to the multiple unit system, the main difference in the systems being that in the case of the former it is possible to control the whole equipment of the train by means of two main cables. Previously, the great difficulty in the way of such a simple arrangement lay in the construction of the controller, it being practically



Part of Traffic Chart.

impossible to carry the whole of the current through one controller.

In the Dick, Kerr system this is rendered possible by the use on the controller of the metallic shield blow-out, which is part of the standard design of their tramway and railway controllers. They contain two power cylinders, each controlling one half of the train—that is, the leading motor-car is controlled from one cylinder, and the rear motor-car from the other. Without, therefore, interfering in any degree with the completeness of the train, it would be possible to divide one of the present trains into two distinct units. In other words, the system embraces most of the advantages of the multiple unit control, without the necessity of employing numerous connections. The train is operated entirely by the motor-man in his cab at the front.



Reversers, blow-outs lowered.
" " in place.
Overload release, open and closed.
Grid rheostat.
Reversers, without blow-outs.

REVERSERS, OVER-LOAD RELEASE, AND RHEOSTAT.

In each cab is a Dick, Kerr DM4 controller, capable, in conjunction with eight reversers, which are bolted up adjacent to their various motors under the floor, of operating the eight motors on the pair of motor-cars.

The two power cylinders of the controller are geared together and operated from a crank handle, each cylinder barrel being flanked by a powerful metallic shield blow-out solenoid. These may be swung open on hinge pins, such action automatically cutting the winding out of circuit, or, if necessary, lifted off and removed for inspecting the cylinders and contact fingers (see illustration on p. 627).

There are also provided two sets of single-pole quick-break knife switches and metallic shield blow-out circuit-breakers, each of these designed for an overload with a calibration of 500—1,600 amperes.

The reversal of direction of the motors is effected by means of a special apparatus operated by the controller reversing barrel. This reversing apparatus carries contacts which are normally left open by gravity, but can be closed by an electro-magnet, which becomes operative through the agency of the controller reversing barrel. There are eight reversers per train, one per motor, which are arranged in four parallels of two in series across the system. In series with each reverser pair are the contacts of two magnetic overload releases, the coils of which are each in the main circuit of one of the motors, its reverser contacts and solenoids. Consequently, whether a pair of motors be in series or in parallel, an overload current in either one will cause both releases to open and cut out the pair. These releases are enclosed in small neat cast-iron boxes mounted on the sides of the car near the truck, facing outwards. When open, a flap falls down, exhibiting "Open," in raised white letters on a scarlet ground, which catches the eye immediately. The releases may also be tripped by hand to cut out any pair of motors that may become disabled.

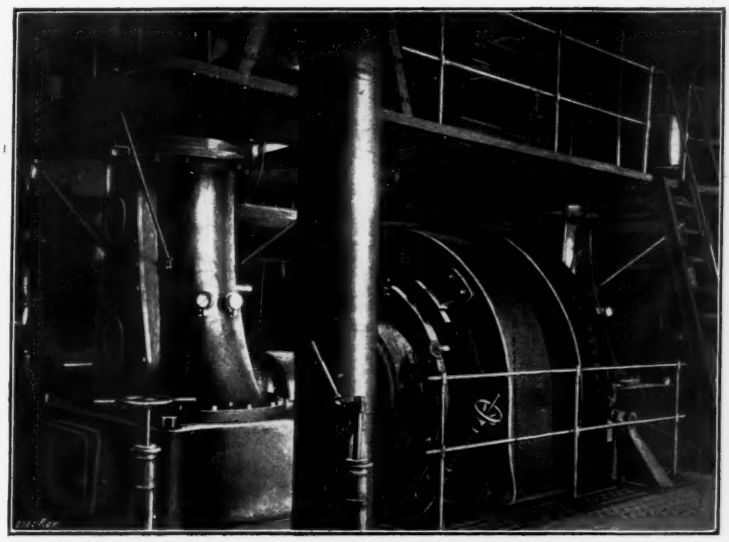
Powerful and certain action of the reversers is secured by a compact magnetic circuit and the free and balanced suspension of a heavy clapper, while uniform and reliable contact is ensured by the use of several independent spring contacts, so hung as to render sticking impossible.

In circuit with each pair of reversers is a cartridge fuse and hand knock-out switch in the cab. The latter is for opening the relay circuits of the reversers in order to cut off the motors, should the controller cylinders stick in any way or an accident be imminent. In accordance with the usual practice, the power cylinder is locked when the reversing is in an "off" position, and only then can the handle be removed, while the reversing is locked when on "reversed" or "ahead" and the power cylinder on one of the notches.

The power couplings between two cars simply consist of stationary male plug contacts in insulating tubes screwed to the ends of the coaches, with dummies facing them on the coaches opposite, into which female plugs, buried in insulating handles at the end of long flexible leads, click home, according to whether connection or disconnection is required. The heat, light, and reverser couplings are mechanically in one and similar in arrangement to the power couplings. They are all mounted about half-way up the car wall comfortably within reach from the platform, thus obviating all risk of getting on the track and receiving shocks from the third rail.

The schedule of trains to be adopted with electric traction is shown on the chart, part of which we reproduce on p. 628.

From what has been said above, it will be seen that the electrification of the railway has not only been carried out in first-class style, entirely by British engineers and workmen, but also embodies many features peculiar to this installation. Since we commenced the publication of this article, the line has been opened for public service with electric traction, and there is no reason to doubt that it will prove successful both financially and from an engineering standpoint. We have already mentioned the names of Mr. J. A. F. Aspinall and Messrs. Dick, Kerr & Co., Ltd., as the engineer and contractors respectively for the conversion of the line to electrical working; no outside consulting engineer was employed.

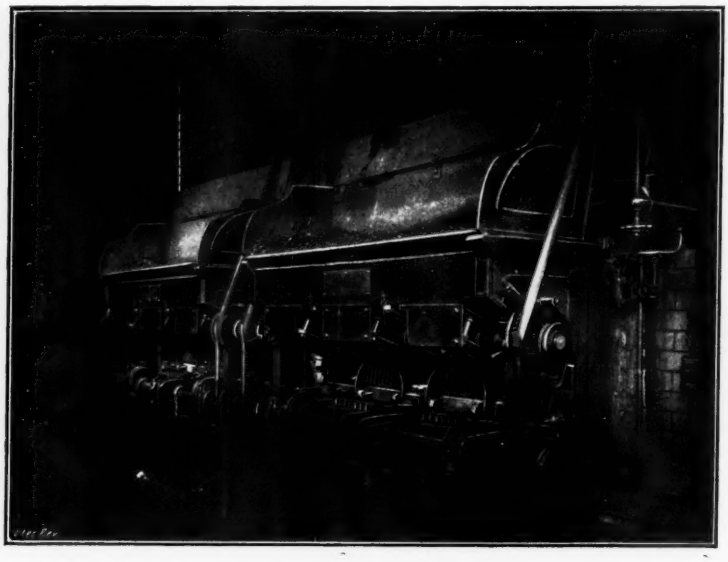


ASTON MANOR: FERRANTI-DICK, KERR STEAM DYNAMO. (See next page.)

We are indebted to these gentlemen and to the railway company for the opportunity to inspect the system, and for the particulars given in this article.

ASTON MANOR ELECTRICITY WORKS.

The Borough of Aston Manor, the youngest of municipal boroughs, formally opened its electric power station and commenced the supply of electricity on September 29th, 1903. Aston Manor, or as it is generally called locally, Aston, is a thickly-populated suburb of Birmingham, and contains a considerable number of factories and workshops allied with the brass trade, among the larger being the works of the General Electric Co., Ltd., and Messrs. Veritys, Ltd.



Boilers and Mechanical Stokers.

The generating station is in Chester Street, and adjoins the Birmingham and Fazeley Canal, the water from which is used for condensing purposes only. Adjoining the station is the dust destructor of the Corporation, which has a small electrical installation for the supply of power to mortar mills, and incidentally to the auxiliary motors in the main generating station.

The engine room is about 80 ft. long by 45 ft. wide, and is lofty and well lighted. It is fitted with a temporary corrugated iron end hung from a light lattice girder, suspended on end carriages which run on the gantry rails. This arrangement admits of extensions to the building and foundations being carried out without exposing the present plant, the end being simply moved along as soon as all the rough work is completed.

The building is of steel, filled in on the boiler house side by brickwork, and on the other side with corrugated iron. The gantry carrying the overhead crane is supported on the main steel stanchions.

The engine room floor is paved with black and white tiles, which gives the station a very clean appearance.

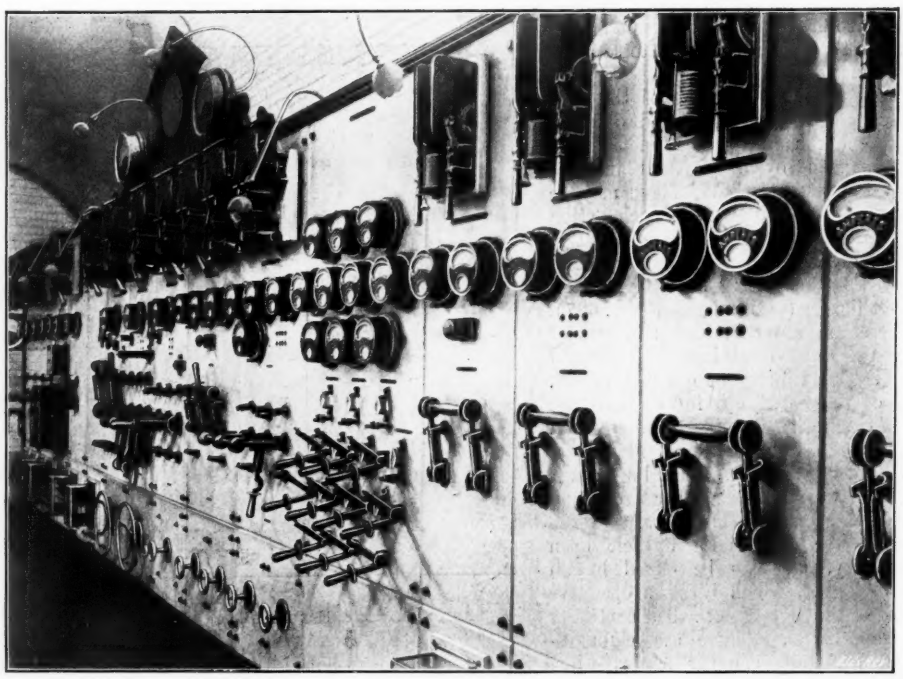
There are three steam dynamos at present laid down, but it is proposed to lay down another 750-kw. set without further delay, to meet the demands of the tramways, which are now being equipped by the Corporation, and have been leased to the B.E.T. Co. for a number of years.

The existing plant consists of two 500-kw. sets and one 200-kw. set. The engines are compound, and are of Messrs. Ferranti's make, while the two larger dynamos are of Messrs. Dick, Kerr & Co.'s make, and the smaller one of British Westinghouse make. The various sets are of the usual type, the armatures and fly-wheels being hung between the two engine bearings. All the engines run at 180 r.p.m., and are fitted with special heavy fly-wheels for a traction load.

The steam supplied to the high pressure cylinder passes through a reheater receiver, and while reducing its own superheat, dries the steam supplied to the low pressure cylinder. The engines are fitted with both expansion and throttle valve governors, the latter acting as an emergency governor. Forced lubrication is used throughout.

The dynamos are arranged to run as either shunt or compound, on the lighting and traction loads respectively.

The balancers of the British Westinghouse Co.'s make, consist of two sets, each consisting of two 50-kw. shunt-wound machines. The four machines run on the same bedplate, and a clutch is provided so that they can be used either separately for balancing purposes, or coupled, one set acting as motors to drive the other set as generators.



Main Switchboard.

Either pair of machines can be run in series as motors off the traction bus-bars, and drive the other two as balancing generators, supplying and balancing the lighting feeders on a small load during the day, as there is no battery in the station; or either pair can be run as simple

balancers on the three-wire lighting system, the other pair remaining stationary.

The switchboard is of Messrs. Johnson & Phillips's manufacture, and consists of 15 panels of polished marble mounted on iron frame work, with cast-iron moulding all round.

The three dynamo panels are each fitted with a circuit-breaker, ammeter, voltmeter plug contacts, shunt regulating switch and resistance, and a triple-pole throw-over switch for switching on to the tramway or lighting bus-bars. There is also a watt-hour-meter for each dynamo placed alongside each machine on the engine room wall, registering the total output. Two spare panels are left for future extensions. There are two panels controlling the four 50-KW. 250-volt balancers.

There is one panel controlling 10 arc lamp circuits, and four three-wire lighting feeder panels, each fitted with a double-pole circuit-breaker operated by one coil only, which is energised by the middle wire, two ammeters, voltmeter plug contacts, double-pole switch, and a three-wire watt-hour-meter. There are also two panels, each controlling two tramway feeders, and the usual Board of Trade panel.

There are illuminated dial voltmeters on swing brackets for the lighting and traction bus-bars, and for paralleling. Surmounting all there is an ornamental cast-iron pediment, containing two feeder voltmeters, and an eight-day clock.

The cables connecting up the machines to the switchboard are of Messrs. Johnson & Phillips's paper-insulated lead-covered make, run on porcelain insulators.

As will be seen from the photograph, there is an interlocking plug in each dynamo circuit, so arranged that when any machine is on the traction bus-bars and is driving the balancing set as a motor-generator, it cannot be switched on to the lighting bus-bars until this plug, through which current is being supplied to the motor half of the set, has been removed.

Messrs. Johnson & Phillips fitted up the test room with instruments of Messrs. Kelvin & White's make; there is also a photometer room attached, fitted with Messrs. Everett, Edgcumbe & Co.'s portable watt photometer. This piece of apparatus is very necessary, as the Corporation supplies all the lamps required by consumers in the district. The tenders for lamps were settled according to the following guarantee formula:—

$$\text{Guarantee} = \frac{U \times P + C}{L},$$

where U = B. of T. units consumed during life of the lamp.
P = price per unit in pence (taken at 3d.).
C = cost of lamp in pence.
L = candle-power-hours given during life of the lamp.

The test room is also fitted up with apparatus to test the coal, water, and oil, and altogether forms a very complete laboratory.

The boiler house contains six Babcock-Wilcox water-tube boilers, two capable of evaporating 4,000 lbs. and four 8,000 lbs. of water per hour at 200 lbs. pressure. They are fitted with the makers' patent "Scotch furnaces," and are provided with Messrs. Vicars's mechanical stokers and Babcock superheaters, fitted with patent interlocking gear to prevent water from the superheaters getting into the steam pipes. A dial thermometer is fitted to each, so that the superheat is always under observation.

The boilers, as well as the steam-pipes and engine cylinders, are lagged with mica, which is in turn protected by planished steel.

A Green fuel economiser of 96 tubes is provided. The flues are all underground. The scraper gear is motor-driven.

The steam piping presents some new features, for which special advantages are claimed. From each pair of boilers there are two pipes running to the engine opposite to it, so that the supply of steam is normally independent of that of any other set. In addition, one pipe of each set is connected to a common pipe, so that any boiler can be connected to any engine. Messrs. McDougall's steam traps are used.

The feed-water is pumped from a well 300 ft. deep adjoining the pump room by means of two motor-driven pumps to a 20,000-gallon tank placed over the pump room. From there it passes through two Boby detartarisers, where the action of the steam (obtained from the neighbouring destructor boilers) and soda removes the temporary and permanent hardness. The water is then pumped at a temperature of 205° to 210° F. into the boilers.

The pumps, of which there are both steam and motor-driven types, four in number, are each capable of delivering 2,000 lbs. of water per hour against a head of 200 lbs. per sq. in. The electric pumps were supplied by Messrs. Mather & Platt, Ltd.

Messrs. Hopkinson's isolating valves are fitted to each boiler, and all the valves throughout are fitted with a special nickel steel alloy to overcome the distortion due to expansion with superheated steam.

The chimney is 150 ft. high, of brick, lined with fire-brick.

The coal is discharged by hand from the canal barges into a suitable shute, from which it is fed through an automatic filler into the buckets of a "Hunt" conveyor supplied by Messrs. Babcock & Wilcox.

The conveyer rises outside the building, then passes along the top of the overhead bunkers, capable of holding 600 tons, where the buckets are automatically tipped. The buckets return below the fronts of the boilers, where, by lifting loose plates, ashes can be removed. The conveyer is capable of handling 12 tons of coal per hour, and is motor-driven.

From the overhead bunkers the coal is fed by Messrs. Avery's weighing hoppers into the mechanical stokers.

The Edwards air-pump is motor-driven, as are also the two Gwynne centrifugal pumps for condensing purposes. The latter raise water from the canal into a 21,000-gallon tank over the boiler house. The water is allowed to flow back to the canal over a 6-ft. weir.

Each engine has a separate condenser, two being of Messrs. Körting's jet type, and one of Messrs. Mirrlees, Watson's surface condensing type. The latter is capable of dealing with 15,000 lbs. of steam per hour, and the latter firm were the main contractors for the condensing plant. The condensed steam from the surface condenser can be discharged either into the main condensing discharge, or into a weighing tank, so that a test can be taken in a very few minutes.

A small carpenter's, fitting, and blacksmith's shop has been equipped for any repairs that may be necessary.

The station wiring for both lighting and motors is supplied from a small subsidiary board, which obtains current from either the main switchboard or the small plant in the destructor house adjoining. The change-over switches, of which there is one at either end for this purpose, are magnetically interlocked so that the supplying end only can switch off. These switches were supplied by the Electrical Trades Supply, Ltd., Birmingham.

Outside, about 16 miles of cables of B.I. & H.C. make have been laid, mostly on the solid system. All the feeder pillars are placed above ground.

The original idea was to put up 100 arc lamps in the streets, but 15 only have been ordered so far, and these are of Messrs. Crompton's make. Ten miles of armoured concentric cable for this purpose have been laid. The lamps will be run 10 in series across 500 volts.

The Corporation obtained powers for free wiring, consequently the residents have taken eagerly to the new light, the equivalent of nearly 9,000 8-C.P. having been connected up in the first three months. The time switch (Kapp's) method has been adopted. The high rate (6d. per unit) is charged between the hours of 5 and 7 p.m., the low rate (1½d. per unit) being charged for the other 22 hours. The consequence is that the "peak" of the load curve is practically flat for five hours each evening, and a very satisfactory load factor is obtained.

There are at present 319 consumers, with the equivalent of 8,840 8-C.P. lamps connected out of 18,760 applied for. The maximum load for this amounts to 250 KW. There are 16 motors of 106 B.H.P. connected, while in addition 229 B.H.P. have been applied for. The rate for power is the same as for light. Each consumer is provided with a time switch of the Reason Manufacturing Co.'s make.

This station also supplies power to the Birmingham Corporation for the Steelhouse Lane-Aston tram route, and will do so until 1906.

When the Aston Corporation tramways are complete, power will be required for 20 cars normally, and 40 on special days.

The destructor plant consists of a 100-KW. set by Messrs. Reavell and the General Electric Co. The boilers, of Messrs. Babcock & Wilcox's make, are heated by the gases from Messrs. Hughes & Stirling's destructors.

The dust destructor plant is only run while refuse is being consumed, and at other times power for the mortar-mills is obtained from the main station, each department paying for any energy it consumes from the other's mains.

Our thanks are due to Mr. Reginald P. Wilson, the consulting engineer, and to Mr. Ballard, the resident engineer, for the facilities given to us to obtain the foregoing particulars.

NOTES.

(*Continued from page* 626.)

South African Notes.—*Johannesburg.*—A movement is on foot to "electrify" a section of the Central South African Railway, between Springs and Krugersdorp, and a consultation has been held with Messrs. Mordey and Dawbarn, the consulting engineers for the electric tramway of Johannesburg. At a special meeting of the Town Council it was resolved to offer the local tramway company £150,000 for their assets. Mr. Nolle, in moving an amendment, that £125,000 be inserted in place of £150,000, said the assets were valued at £50,000, that was taking the scrap value of the rails and the cars. The extreme time that the tramway company could carry on its business at a profit before the electric trams were in working order would be two years from August, 1903. Taking as a basis year 1896, which was the largest profit-earning year in the history of the tramway company, £24,700 was earned, and it was calculated that the profit in two years would be £49,000, roughly speaking. The valuation of the assets arrived at on that basis was £100,000. Then, further, there was the possibility of the horse trams hampering the work of construction of the electric tramways, and the recommendation was that a further year's profit be added in the offer to be made. He thought that £125,000 was a very ample offer, and he did not think the Council was justified in paying more for what must inevitable be scrap iron in two years' time. It was not conceivable that the tramway company should attempt to run horse trams in Johannesburg once the electric cars had started running.

Delagoa Bay Electric Tramway.—The accompanying picture shows the new electric tramway service at Lourenço Marques, which was recently inaugurated with great ceremony by the local authorities. The system was designed by Messrs. Macartney, McElroy & Co., Ltd., of London, the cars being supplied by Messrs. G. F. Milnes and Co., of Hadley, Salop. The dynamos, by the Lancashire Dynamo Co., have each a capacity of 198 KW. at a voltage of 550; the boilers, by Babcock & Wilcox, have a heating capacity of 1,426 ft. each. The trucks were built by the McGuire Manufacturing Co. The tramways were constructed by the Delagoa Bay Development Corporation, Ltd., who acquired the concession originally granted to the Tramways Electricos de Lourenço Marques.

East London (*Cape Colony*).—The recently-presented Mayor's minute, *inter alia*, states that abnormal progress was made, during the municipal year just closed, in local electrical undertakings. Street lighting was largely extended, there being now 384 16-C.P. and 14 32-C.P. incandescent lamps, and 21 arc lamps. The number of consumers taking current is 848 as against 630 at the corresponding period last year.

Our Durban correspondent writes:—

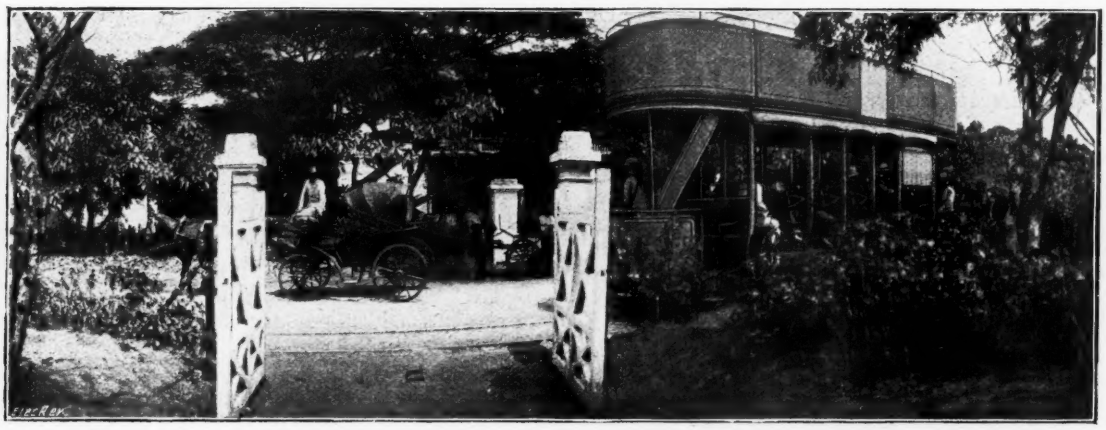
"*Harrismith, Orange River Colony.*—The work in connection with the electric light station at Harrismith is being rapidly proceeded with, and it is hoped to have the plant in operation by July 1st next. Mr. Sydney Faithfull is in charge of the construction for the consulting engineers, Messrs. Mordey and Dawbarn. The system is to be single-phase alternating, with a pressure of 200 volts at the consumers' terminals, the charge for lighting being 10d. per unit. The plant has not yet arrived, but 185 KW. is to be installed at present, with two boilers (Climax) and three engines by Howden and Co. The estimated expenditure per KW. is £80.

"*Port Elizabeth, Cape Colony.*—The borough electrical engineer, Mr. B. Pape, who has recently arrived at Port Elizabeth, has the electric lighting scheme, which will be of his own design, well in hand. It is proposed to spend £72,000 on works, and £12,000 on public lighting. The public lighting will consist of 54 arc lamps, taking 10 amps., besides 400 ½-amp. and 50 1-amp. lamps of the Nernst make. The system at the start is to be all low tension, on the three-wire system, with 440 volts across the outers, the mains to be of paper insulation and lead sheathed. The plant will consist of two 400-KW. turbine generators, surface condensing plant, and three boilers of a type not yet decided on."

Ladysmith.—The electric light is not so much in evidence locally as it might be. A correspondent (Mr. G. F. Combes) complains in a Maritzburg paper that the service is inadequate, and asks:—"How long is this kind of thing going on? The people in this suburb are very heavily rated, and what do they get from it? The electrical engineer is supplied with a horse to see that the lamps are lit."

Bulawayo.—A reduction in the cost of electric lighting is pending, but "is postponed for the present as Sir John Willoughby has departed for England. The subject will probably be discussed (by the municipality) on the return of Colonel Heyman, at the end of April."

Pretoria.—In the course of a descriptive article on the changes which have been effected in the Central South Africa Railway workshops since the advent of Mr. Hyde, the chief locomotive superintendent, twenty months ago, the *Rand Daily Mail* says:—



A View on the Delagoa Bay Electric Tramway.

"Overhead electric cranes have been put in. In the new erecting shop under construction there are two of 40-ton capacity, whilst another (Craven) of 35-ton capacity is on order. Electricity is, of course, especially suited for such intermittent work on the system, which holds good for all machinery of 'no work, no waste of power.' Indeed, it may be safely estimated that motor driven machines save 20 per cent of power compared with the old steam-engine shafting and belting."

Transvaal.—Mr. T. M. Cullinan, presiding recently at the first ordinary general meeting of the Premier Diamond Mining Co., Ltd., incidentally stated that a six-pan gear was in course of erection, and that in connection with same "we are putting in an electric light installation, and should nothing unforeseen happen, the entire plant will run day and night, the same as your No. 1 gear."

King William's Town.—Messrs. Ryan and Petersen, electrical engineers, announce that they have removed their business to "larger and more central premises, situated in Fleet Street, opposite the Central Hotel."

Potchefstroom.—The town electric lighting scheme has at last been decided upon, the tender of the local company having been accepted by the Council, in consultation with the Government electrical engineer. Half the arc and street lights are to be in operation by July 1st, and the whole plant is to be duplicated by the end of the year.

London Electrical Contractors' Association Dinner.—The third annual banquet of this Association took place at the Holborn Restaurant on Wednesday evening last, the President, Mr. E. L Berry, in the chair. There were present about 260 members and guests, including several members of the National Electrical Manufacturers' Association, the National Electrical Contractors' Association, consulting engineers, and other visitors.

After the loyal toasts had been duly honoured, "The London Electrical Contractors' Association" was proposed by Mr. B. H. Rolfe, who referred to the rapid progress made by the Association in the face of great difficulties. It was now well established, and was recognised by Government departments and municipal autho-

rities. Successful opposition had been offered to free wiring clauses, a system of classifying and certifying workmen was being organised, and the *Electrical Contractor* had been founded. Consulting engineers viewed with favour the consolidation of the interests of contractors. In reply, the President said that the association was in no way antagonistic to municipal engineers, many of whom were present that night. They strove to maintain a high standard as regards both their membership and the efficiency of their workmen. The association had appointed a standing committee to deal with complaints, and a joint committee to settle differences with manufacturers. In conclusion, the President pronounced a eulogy on the merits of the hon. secretary, Mr. E. J. Hogan, and presented him, on behalf of the association, with a b autiful silver tea service. Mr. Hogan briefly acknowledged the gift.

Mr. R Tweedy Smith, hon. solicitor, proposed "Kindred Associations," and alluded to the cordial relations obtaining between them and the L.E.C.A. Mr. W. Davenport, secretary of the N.E.M.A., and Mr. E. C. Wallis, president Northern Section N.E.M.A., replied, emphasising their cordial sympathy with the objects of the Association and the mutual benefits derived from their intercourse. Lastly, Mr. A. Rashleigh Phipps, past-president, proposed the health of the President, who briefly acknowledged the compliment.

A programme of music was performed during the banquet by the Casino Orchestra, and a number of songs and musical sketches were interspersed between the toasts; in fact, the proceedings were in all respects harmonious and agreeab'e.

Ilkeston Tramways.—The Ilkeston Corporation tramways employés held their first annual social and dance in the Town Hall on Tuesday, April 12th. The M.Cs. were Messrs. H. W. Seymour and C. V. Scholefield, of the Electricity Department, who were responsible for the musical part of the programme. Amongst those present were Mr. A. C. Gilbert, the manager, and Alderman S. Robinson, chairman of the Tramways Committee.

Personal.—The Preston Tramways Committee has appointed Mr. E. Lafferty, late sectional inspector at Bradford (Yorks), as traffic superintendent.

The Burnley T.C. has increased the salary of Mr. Mozley, tramways manager, from £350 to £400 per annum.

At a meeting of the staff and employés of the Sunbeam Lamp Co., Gateshead, on the 8th inst., the opportunity was taken of presenting the assistant manager, Mr. H. W. Edmundson (son of the managing director), on his approaching marriage, with a silver tea service and carver. The secretary, Mr. T. J. Grainger, made the presentation, and in doing so spoke of the excellent relations of the management and workpeople, and the high opinion they had conceived of Mr. Edmundson's abilities. He had not only gained the confidence, but the affection and esteem of every one in the place, and it was well in these days of competition that such relations existed, for it required a long and a strong pull, and a pull altogether, to win success. Mr. Edmundson responded in suitable terms.

Mr. Percy Longmuir, of University College, Sheffield, has been appointed junior assistant in the Metallurgical Department of the National Physical Laboratory. Mr. Longmuir is a pupil of Prof. Arnold, and has for two years been engaged in research as a Carnegie scholar of the Iron and Steel Institute. He will at present assist Dr. Carpenter in carrying on the work undertaken by the Laboratory for the Alloys Research Committee of the Institution of Mechanical Engineers.

Shock Fatalities.—The *Glasgow Herald* says that on 8th inst. a young man, named William Noble, met his death through touching one of the three electric light cables that supply the electric light to Dingwall from the generating station at Strathspeffer Spa. It appears that Noble climbed the pole carrying the cable, and instantly fell to the ground dead on touching the wire, the points of the fingers of his left hand having been burnt away.

An inquest was held last week into the cause of the death of Thomas Price, which occurred in the Tirydail Colliery, on March 28th. The medical and other evidence showed that death was caused by electric shock, Price having touched a 400-volt cable. His feet were wet at the time.

New Refuse Destructor at Watford.—A four-grate Meldrum destructor has recently been erected at Watford in combination with a 30 ft. × 8 ft. Lancashire boiler. The steam generated is to be used for sewage pumping, and it is expected that an annual saving of £900 will be made in the cost of fuel. In addition to the boiler, a Green economiser, and a Boby detartariser have also been installed. Watford holds the distinction of possessing the first destructor erected in the county. The total cost of the installation is under £7,000, and the annual cost is put down as follows:—Interest and sinking fund, £460, labour and supervision, £410; repairs, £100; total, £970. Against this are set the following savings:—Coal, £890; wages, £177; total, £1,067. Excluding any possible revenue from the sale of clinker, there is thus an anticipated profit on the undertaking of about £100. What is more important, however, is that the insanitary method of refuse tipping will be abolished, a system which was the cause of a serious outbreak of diphtheria in the vicinity of the tips in 1900.

Municipal Tramways and Private Companies.—A Manchester correspondent writes:—"The recent decision of a Select Committee of the House of Lords, in favour of giving a private company running powers over the municipal tramways of Newcastle, has aroused a good deal of feeling amongst the municipalities of the country. It is regarded as a precedent which, if sanctioned by law, will have a widely-extended application, and will operate disastrously to the ratepayers in many places. Some time ago an association was formed to deal with matters in which the common interests of municipal tramway undertakings were concerned; and the conveners, Mr. W. Paton, chairman of the Glasgow Tramways Committee, and Mr. D. Boyle, chairman of the Manchester Tramways Committee, have summoned a meeting of representatives of municipal corporations, to be held at the Westminster Palace Hotel on Tuesday, the 19th inst, to discuss the advisability of taking concerted action in the present emergency.

"The chairman of the Manchester Tramways Committee has expressed his views on the subject very freely to a Press correspondent.

"Mr. Boyle considers the decision of the House of Lords Committee a reversal of the hitherto recognised policy of allowing corporations to maintain control over matters within their own areas."

Electricity v. Gas.—Writing to the *Hornsey Journal*, Mr. George Herbert states that after 12 months' experience of electric light in place of gas, he finds a saving is effected by the former of 12s. in £13 during the year, to say nothing of the more important advantages derived from its use, in connection with improved conditions of living, and absence of injury to decorations. The installation comprises the equivalent of 32 8-c.p. lamps, the renewal of which was duly allowed for, and as gas was still used for boiling water, the full charge for this was added to the electricity bill before making the comparison. This result exhibits a mysterious discrepancy when placed beside the frenzied assertions of the partisans of gas, who say that electricity costs from 7 to 15 times as much as gas.

Junior Institution of Engineers.—At the meeting of this Institution held at the Westminster Palace Hotel on April 8th, the chairman, Mr. Samuel Cutler, jun., M.I.Mech.E., presiding, a paper on "Heating and Ventilating Small Workshops," was read by Mr. Kenneth Gray, M San.Inst.

The Berlin Electric Railway.—The official returns have just been issued relating to the working results for 1903 of the first electric railway which was established in Berlin, and the initial section of which was opened for traffic in February, 1902, the remaining sections being inaugurated gradually in the same year. Thus the results for 1903, although showing satisfactory progress, are not strictly comparable to the incomplete period of nearly 11 months during which only one portion of the railway was in operation. The line, which is known as the elevated and underground electric railway, carried 29,628,463 persons in 1903 as compared with 13,813,994 passengers in 1902, while the short level section associated with the undertaking transported an additional 2,507,649 persons as against 1,227,010 in the preceding period. The total working receipts amounted to £190,903, and the expenses to £100,126. After providing for the interest on the bonds, which amount to £390,000, and making provision for reserve and renewal funds, there remains a net profit of £57,523. It is proposed to pay a dividend at the rate of 3½ per cent. for the year on the share capital of £1,500,000. In the preceding year the railway was worked by the contractors, who guaranteed and paid 4 per cent. interest on the share capital for 1902, at the end of which the railway was transferred to the proprietary company.

Sheffield Municipal Tramways.—In *Public Works* for February there appears a comprehensive article on the Sheffield Electric Tramways, from the pen of Mr. C. F. Wike, city surveyor and engineer. The routes now open for traffic embrace nearly 35 miles of route, comprising 63 miles of single track; if the remaining authorised lines are constructed, the total length of single track will be brought up to 90 miles. The estimated cost of the completed scheme amounts to over £1,000,000. An interesting feature of the work is a cable tunnel beneath the mill-dam which adjoins the station; the tunnel is constructed of cast-iron segments bolted together and surrounded with concrete, and is 110 ft. long, 7 ft. high, and 5 ft. wide inside. The tunnel cost £3,500. The power station has been largely extended since we published a description of the undertaking in September, 1899, and now contains three 225-kw. dynamos driven by Allis horizontal compound engines, two 500-kw. and two 1,000-kw. dynamos driven by Cole, Marchent & Morley vertical compound engines. All the dynamos were supplied by the B.T.H. Co. There are about 150 cars in daily use, many being single-deckers, on account of the steep gradients, sharp curves, and low bridges. The original chilled-iron wheels have been replaced by steel wheels. During the year ended March 25th, 1903, nearly 57 million passengers were carried.

Selenium Cells.—The question whether the diminution in the resistance of selenium cells submitted to a more or less strong illumination is due to chemical processes, as suggested by Bidwell, is complicated by the fact that selenium, on coming into contact with any metal and especially on being heated, will form chemical compounds. Now, selenium cells are made by winding on a plate or a cylinder of insulating material copper or platinum wires; after these have been coated with selenium, they are kept at a temperature as high as 200° C. for five hours, the selenium being crystallised. In a paper recently published in the *Physikalische Zeitschr.*, Mr. G. Berndt uses a body which, while having an electric resistance of no excessive magnitude, will not form any chemical compound with selenium, *i.e.*, carbon. The selenium cells were made as follows:—A glass plate 5 cm. in breadth, and 6 cm. in length, was covered with carbon threads, about 4 cm. in length and 0·2 mm. in diameter, placed at distances apart of 1·5 to 2 mm, the first, third, &c., threads projecting by 1 cm. on one side, and the second, fourth, &c., threads on the other. These projecting ends of either group of carbon threads were connected to one another either with or without the help of a metal. After the plates had thus been

prepared and well dried, they were coated with about 1½ grms. of pulverulent selenium, which was uniformly distributed and melted on the glass plate; after a rapid cooling had been produced, the selenium was crystallised by a moderate heating.

Now in opposition to Bidwell's hypothesis, two selenium cells thus prepared proved sensitive to light; in both of them the resistance decreased by about 55 per cent. after the cell had been exposed for five minutes to the action of a 16-candle incandescent lamp placed at a distance of 10 cm. The author also shows that there are no chemical processes produced by the lighting, and disappearing as soon as the cells are darkened. Such processes should, in fact, be attended by the evolution of positive or negative amounts of heat, and as shown by special experiments, there is no evolution of heat worth speaking of. The sensitiveness was found to decrease for decreasing wave lengths. As regards the connection between the sensitiveness of the cells and the candle-power of the lamp, the law enunciated by Rosse (*Phil. Mag.* 6, 747, 1874), according to which the sensitiveness to light would be proportional to the square root of the luminous intensity, is confirmed.

Selenium cells on carbon show finally the property of maintaining their resistance in the dark at constant figures, apart from any variations due to temperature, in opposition to the behaviour of ordinary selenium cells on metallic wire. In order to account for the photo-electric properties shown by selenium cells, the author suggests the following hypothesis:—There are two modifications of crystalline selenium, these modifications being in a dynamical equilibrium, which is displaced under the action of an illumination, to be re-established as soon as the illumination ceases.

Appointment Vacant. — An electrical engineer for Stoke Newington.

THE CENTRAL STATION ENGINEER.

The Lincoln Town Council is going to increase the salary of Mr. S. Clegg, electrical engineer, by £50 a year, until a maximum of £500 is realised; Mr. Clegg will undertake the management of the proposed electric tramways.

The Tramways Committee of Hull Town Council has appointed Mr. W. T. Robson, acting chief assistant at the power station, as rolling stock electric assistant, his salary being increased from £130 to £150 per annum. Mr. H. H. Dadson has been appointed outside electrical equipment assistant, and his salary increased from £104 to £120, and Mr. C. D. C. Cummins has been appointed power station electrical assistant.

Mr. M. B. Henry, chief assistant at the Nelson Corporation Electricity Works has been appointed electrical engineer at Radcliffe at a salary of £150 per annum.

On Tuesday last week the staff and workmen employed at the West Ham electricity works presented Mr. J. K. Bock, the retiring electrical engineer, with a gold watch. The presentation was made by Mr. W. J. Bullock, the new chief. Mr. Bock, in acknowledging the gift, said that though they had only had one master he had been subjected more or less to 48 rulers.

NEW COMPANIES REGISTERED.

Lowne Electric Clock and Appliances Co., Ltd. (80,531).—This company was registered on March 30th, with a capital of £8,000 in £1 shares, to adopt an agreement with R. M. Lowne, B. J. M. Lowne and B. T. Lowne, and to carry on the business of automatic electric cloth and time-piece makers, automatic electric pendulum makers, electric recording vane and anemometer makers, electric signal makers, air meter, clock, watch and chronometer makers, scientific instrument makers, jewellers, electricians, electrical engineers, &c. The first subscribers (each with one share) are:—R. M. Lowne, Ravenscroft, Catford, scientific instrument manufacturer; A. J. M. Lowne, Ravenscroft, Catford, scientific instrument maker; B. T. Lowne, Ravenscroft, Catford, scientific manufacturer; Mrs. E. B. L. H. Liskeard, 13, Sidney Road, Beckenham; G. F. Wallace, 52, Guildford Street, W.C., mining agent; W. W. Smiles, 7, Laurence Pountney Hill, E.C., chartered accountant; and W. A. Lawder, 7, Laurence Pountney Hill, E.C., chartered accountant. No initial public issue. The number of directors is not to be less than two nor more than five; the first are R. M. Lowne, B. J. M. Lowne and B. T. Lowne; qualification, £100; remuneration as fixed by agreement. Registered office, Ravenscroft, Bromley Road, Catford.

Miniature Arc Lamps, Ltd. (80,532).—This company was registered on March 30th, with a capital of £2,000 in £1 shares, to adopt an agreement with A. E. Parker and P. E. V. G. Plater, to manufacture and deal in lamps, dynamos, cables, insulating materials, accumulators, telephones and other apparatus, and to carry on the business of electricians, engineers, suppliers of electricity for light, heat, motive power or otherwise, &c. The first subscribers (each with one share) are:—A. E. Parker, 18, Air Street, Regent Street, W., gentleman; P. C. P. Richardson, 136, Westbourne Grove, W., electrical engineer; W. Mossop, 52, Queen Victoria Street, E.C., electrical engineer; S. B. Marshall, Selhurst, Walton Crescent, Wimbledon, electrical engineer; P. E. V. G. Plater, 38, Conduit Street, W., gentleman; J. R. Crellin, 74, Empress Avenue, Ilford, secretary; and J. Johnstone, 17-18, Basinghall Street, E.C., solicitor. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, 50 shares; remuneration, £25 each per annum.

Traction and Power Agency, Ltd. (80,557).—This company was registered on March 31st, with a capital of £500 in £1 shares, to carry on the business of omnibus, carriage, vehicle and boat builders, carriers, tramway and railway proprietors, cycle and motor manufacturers and dealers, electrical and general engineers, &c. The first subscribers (each with one share) are:—P. F. Stevens, 135, Cornwall Road, W., clerk; A. J. Towns, 124, Portobello Road, W., clerk; C. B. Ridley, 2, Esmond Road, Bedford Park, W., accountant; M. N. Ridley, 11, Dartmouth Street, Queen Anne's Gate, S.W., civil engineer; S. C. Russell, Dunrobin, Cedar Road, Sutton, Surrey, clerk; A. Schonberg, 28, Victoria Street, S.W., civil engineer; and W. G. Davis, 24, Mansfield Road, N.W., secretary. No initial public issue. Table "A" mainly applies. Registered office, 92, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Madras Electric Tramways (1904), Ltd. (80,361).—A trust deed, dated March 18th, 1904, to secure £50,000 first mortgage debenture stock, has been registered. Property charged: Freehold land in Madras and the company's undertaking and property, present and future, including uncalled capital. Trustees: Anglo-Indian Debenture Corporation, Ltd., 75, Lombard Street, E.C.

Hyde Electrical Manufacturing Co., Ltd. (77,929).—£900 debentures created and dated March 15th, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holders: Miss S. Harrison, Woodend Lane, Hyde, Ches., and A. H. Davies, Wilton Villa, Caerau, Mon.

London Electromobile Syndicate, Ltd.—£996 19s. debentures, created March 22nd, and dated March 29th, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

ELECTRICITY SUPPLY ACCOUNTS.

Northampton Electric Light and Power Co., Ltd.

The Northampton Co. has apparently had a prosperous year on the whole; the feature which is most marked being the development of motive power supply—the motors are largely hired out by the company, and in this direction the company's area appears to offer promising results. An increased area of supply may also lead to further development in the near future. The total working costs at 1·72d. per unit are an improvement on last year, and out of the gross profit a sum of £1,200 was placed to the depreciation fund—the latter, however, being depleted by a sum of £1,760 on account of sundry plant sold during the year.

The prices charged are:—For private lighting, 6d. and 3d. per unit on the maximum demand system; power, 2d. per unit with substantial discounts. The engineer is Mr. G. H. Jackson.

General Statement.

For year ending December 31st—	1903.	1902.
Total capital expended	£91,814	£85,435
Number of units sold—		
Private supply	453,768	338,541
Equivalent No. of 8-c.p. lamps connected	40,855	32,967
H.P. of motors connected	252	102
Maximum load in kw.	540	430
Revenue account—		
Gross revenue	£8,183	£7,639
„ expenditure	£3,242	£2,927
„ profit	£4,941	£4,712
Average inclusive price obtained per unit—		
Private lighting	4·32d.	5·40d.

Revenue Account for Year ending Dec. 31st, 1903.

Gross revenue	£8,183 = 4·32d. per unit.
Works and distribution costs	£2,007 = 1·06d. „
Total working costs	£3,242 = 1·72d. „

Profit Statement.

Interest and dividends, &c.	£3,738
Balance brought forward	—207
Balance on year's working carried forward ...	210
To depreciation	1,200
Gross profit	£4,941

The Blackheath and Greenwich Electric Light Co., Ltd.

The report of the Blackheath and Greenwich Co. is of a very promising character, and very considerable increases are recorded in lamp connections and output, the latter having reached 1,180,271 units. During the past year the company acquired the Lewisham and District undertaking, and this, with the acquirement of the Crystal Palace Co.'s concern, should greatly increase the company's scope of operations. The working costs are a reduction on the previous year, and as a result of the year's operations a very considerable balance is carried forward.

The prices charged are:—Private supply, 6d., and power 3d. per unit. The resident engineer is Mr. J. A. Constable.

General Statement.

For year ending December 31st—	1903.	1902.
Total capital expended	£273,303	£221,217
Number of units sold—		
Private supply	1,180,271	890,202
Equivalent No. of 8-c.p. lamps connected	60,540	44,916
Maximum load in kw.	1,035	927
Revenue account—		
Gross revenue	£19,450	£14,334
„ expenditure	£8,409	£6,979
„ profit	£11,041	£7,355
Average inclusive price obtained per unit—		
Private lighting	3·96d.	3·86d.

Revenue Account for Year Ending Dec. 31st, 1903.

Gross revenue	£19,450 =	3·96d. per unit.
Works and distribution costs ...	£4,778 =	·97d. „
Total working costs	£8,409 =	1·71d. „

Profit Statement.

Interest and dividends	£7,481
Balance on year's working carried forward ...	5,220
Balance brought forward from 1902	—2,910
To depreciation	1,250*
Gross profit	£11,041

* This amount, together with £1,000 depreciation, 1902, applied to reduction of capital account.

CITY NOTES.

Willans & Robinson, Ltd.

The ordinary general meeting of this company was held on Wednesday at Cannon Street Hotel, E.C., under the presidency of Mr. Mark Robinson.

In moving the adoption of the report (see Elec. Rev., April 8th), the Chairman said that as the report implied, three separate causes had combined to place them in their present position, and they needed to be carefully studied, separately from each other, because they were not suffering from one trouble alone. Important as were the issues of the Queen's Ferry undertaking, it was not, in their opinion, the present non-success of those works which threatened them the most seriously. They asked their attention in the first place—and the more earnestly because their attention was, perhaps, in danger of being distracted by the more visible trouble elsewhere—to the serious falling-off in their original business of engine-building. This was not confined to themselves alone, but in this case it was accentuated by the fact that their old monopoly in quality and efficiency, which for so long gave them a commanding position amongst makers of high-speed engines, had been impaired by an undoubted improvement in rival designs. The Willans engine was not less good than it was, but it had rivals now on its own plane, which was not the case formerly, so that over and above the general depression from which they suffered in common with others, they had experienced a far more effective competition, which had diminished both the volume of their orders, and the rate of their profits. From these causes the Rugby business had done badly. What was not foreseen, however, was the second cause of their troubles, the serious loss at Queen's Ferry, which had swallowed up the profit at Rugby, and given them a debit balance. Without going into the early history of the Queen's Ferry undertaking, and the reasons for what was done there, he would say that the primary cause of the loss had been the repeated postponements of the commencement of work on a commercial scale, due to difficulties in technical points of manufacture in a somewhat special branch, that of large tube-drawing, which lay a little outside the ordinary operations of engineering. Though the directors had no reason to anticipate such difficulties, they had no wish to disclaim responsibility for the failure to foresee them. They took what was believed to be good expert advice in that special branch, and had reasonable assurance of early success. All difficulties of any importance had now been overcome, but in the process a great expenditure, which they must treat as a loss, had been incurred. Queen's Ferry contained another department, however, the steel works and steel foundry. The making of the special quality steel (of tube-making quality) which they desired to produce, proved to require a great deal more experimenting than they had foreseen, and so did the difficult art of steel founding. In finishing the extensions at Rugby and the new works at Queen's Ferry, they had had to incur liabilities, or to make actual expenditure, nearly up to the amount of the shares which, three years ago, they were authorised to issue. It had been intended to issue them last year, and had they done so they would now have had the reserve fund at their disposal, and could, if they judged it right, pay the preference dividend out of it. Unfortunately they yielded to the suggestion to postpone the issue and to borrow from the Bank, on the ground that whereas last spring the money market was in an unfavourable state, this spring it might be better. Needless to say, it was worse, so that the idea of an issue of shares could not be entertained. To recapitulate, they had, first, a poor profit at Rugby; secondly, a heavy loss at Queen's Ferry; thirdly, a debt which precluded any use being made of the reserve fund in aid of the profit and loss account. Explaining what the directors had done to remedy the state of affairs, the Chairman said that it was decided to confer informally with some of the largest shareholders. They invited the 25 largest holders, excluding directors, but including all holders of 700 shares and upwards, to meet them. About 12 or 14 met them in conference, when they laid before them, not only their financial needs, but the whole position of the company as far as they then knew it. As an informal advisory committee, five gentlemen were appointed, and visited Rugby and Queen's Ferry, and eventually they reported to another meeting of the same shareholders, with the directors, in the sense that the steel works and foundry at Queen's Ferry, but especially the foundry, should be closed; that no dividend should be paid; that every economy should be practised; and that the company should seek powers to borrow the necessary sum upon the security of the reserve fund investments. Fully adopting the recommendations, the directors had given orders to close the steel works and foundry so far as was consistent with the completion of orders in hand, and they had given notice of a resolution empowering the directors to borrow up to the limit imposed by the articles—namely, about £83,000. The Chairman proceeded to deal at considerable length with the financial position of the company and the methods by which it was proposed to raise money, and said, in conclusion, that they had taken up a well-tried type of steam turbine, and had in hand an improvement in the Willans engine itself which would, he hoped, restore it to much of its relative superiority.

Mr. Gough seconded the adoption of the report. A lengthy discussion followed, in the course of which an amendment that the report be not adopted and that an advisory committee be appointed, was lost.

Mr. Balfour proposed, and Mr. Robinson seconded, a motion to the effect that Mr. Peach and Mr. Geo. W. Anderson should be added to the board.

The Chairman pointed out that such an appointment would have to be made at a meeting called specially for that purpose; but the directors would, he said, welcome the addition of Mr. Peach and and Mr. Anderson. He promised that a meeting for that purpose should be called as soon as possible, within a fortnight. Dealing with certain points raised in the course of the discussion, the chairman said that while it was true that their previous reports had been optimistic, the board believed them to be true reports, and they *were* true reports. Money had been lost by *not* making boilers and in experimental work. With regard to the debts outstanding to them, a large number of them had been paid since the report was issued, and much of the money was owing by Corporations with whom they did an extensive business, and who did not pay up at once. A complaint had been made with regard to a donation to the Engineering Standardisation Committee. He might tell them that that Committee had done, and was new doing, a great amount of very useful work for the engineering trades—a work from which they, in particular, hoped to derive much benefit. When the donation was promised, however, they did not know what their position was. With regard to the Paris engine, it was, he believed, an identical engine with that which Capt. Sankey had said he had seen working so successfully at Pontypridd. It had been stated that they had admitted that the engine was a failure; they had done nothing of the kind. As to their gas engine work, that was, of course, experimental. The first gas engine they turned out was sent to Redditch, where, unfortunately, they became the victim of local politics. There was a gas party and a steam party, and their engine was cast out because it did not give exactly the specified horse-power. It has since been replaced by another, which had given no trouble.

The report was then adopted unanimously, and the retiring directors and the auditors were re-elected.

The Chairman then moved the following resolution: "That the directors be, and they are hereby, authorised to borrow, for the purposes of the company, any such sum or sums of money as (when added to the amount, if any, for the time being owing in respect of the existing debenture stock and other sums borrowed by the company), shall not exceed 50 per cent. of the present paid up capital of the company, upon such terms and conditions, to bear interest at such rate, and to be secured in such manner, as the directors may determine." This was seconded by Dr. Sumpner and carried.

The meeting, which had lasted for two hours, then terminated.

South Wales Electric Power Distribution Co.

Mr. R. Forrest presided at the second ordinary general meeting of this company held at the generating station, near Treforest, on Saturday last. The directors' report for 1903 showed that the construction of the company's undertaking had been proceeded with during that period. For the short time that the station at Bridgend had been at work it had shown good results, and the business of the company in that district was constantly increasing. The stations at Pontypridd and Cwmbran were ready to deliver current. The buildings at the Neath station had been completed, the plant was in course of erection, and it was anticipated that the station would be at work in about three months.

The Chairman said that the station had, for the last two or three days, been delivering current to a customer for sale, and their customers would as soon as possible, within the next few weeks, be connected with the station and supplied by them. The Cwmbran station was in practically the same position, although it would be a few days later in beginning to deliver the current. With regard to the company's prospects generally, the only fear that the directors had at any time was that the use of electricity in works, and more especially in collieries, being somewhat of a novelty in England and Wales, a considerable time would elapse before a large supply of current would be required. They were, however, glad to be able to say that so far as they had gone this difficulty had been most satisfactorily solved, and their difficulty was much more likely to be one of being ready to supply the demands which would be made upon them. Already the customers secured and those with whom they were negotiating were more than sufficient to absorb the whole of the power which could be generated at this and the two other stations at Bridgend and Cwmbran. The directors thought that increased power would have to be provided at the three stations within the near future, and the customers that the company had so far obtained did not touch the other two reasons of supply to which he desired to call attention. Twelve or 18 months ago it would have been said by any engineer that if there

was one thing for which electricity was not suitable it was for coal winding, but the directors were glad to be able to report that this difficulty had been solved with advantages which were greatly in excess of those obtained when steam engines were used. In the Little Rhondda, so far as their mains were at present laid, the collieries with one exception, and with which they were negotiating, would take their supply of current from them. Practically the same thing obtained in the larger Rhondda, with the exception of two collieries, with which they were still negotiating, and it was hoped that they would also take a supply of current later on. There was one other utilisation of electricity which was now rapidly coming to the front, viz, the working of railway traffic electrically. As a director connected with one of the local railways, he was going abroad with some of his colleagues next week to investigate what was being done in other countries. It was pretty certain that in the near future some of the many railways in South Wales—and there was no part of the country where there were more of them than in this district—would require to use electricity for the cheap propulsion of their trains. From whom did they think they would get it cheaper or so rapidly as from this pioneer company, which had its installations ready for work?

Notting Hill Electric Light Co.

Sir W. Crookes presided at this company's meeting held on Monday last at Winchester House. In moving the adoption of the report (see our issue of February 26th), he referred briefly to the capital account, and showed that 5,000 additional 4 per cent. debentures had been issued to meet capital expenditure, so as not to increase the share capital until compelled. The year's outlay was £6,077, mainly for the purchase of additional converters. It might be necessary to increase the capacity of the mains so as to deal with the larger amount of current taken in bulk from the Wood Lane station, and also to increase the storage power. They had spent £17,335 in excess of the capital received, the principal part of the difference being met by using the reserve fund in the business. Under all the circumstances, the revenue account was satisfactory. The cost per unit had decreased, and economies had been effected ranging over all the items in the accounts. Cost of coal worked out at ·85d. per unit; this was higher than the cost of coal at Wood Lane, which was less than ½d. last year. The reason was that the steam plant at the company's own station was only running for two or three hours per day, in order to take the peak of the load. The company paid £6,012 to Wood Lane for 1,567,674 units, or less than 1d. per unit, while for the previous year they paid only £192 less for 1,228,900 units; so that, for that extra £192, they obtained considerably over a quarter of a million additional units. Those costs did not include interest on debenture stock and sinking fund. The total costs amounted to just over 1½d. per unit for 1902, and were rather over 1¼d. for 1903. The amount paid for rates was nearly ½d. per unit sold. The management expenses were £8,444, or £120 in excess of 1902. The cost per unit was reduced from ·68d. to ·6d.; this item had shown only very slight increase for some years past. The total expenses charged against revenue were £14,425, against £14,228 in 1902, and the total costs per unit were 2·52d., against 2·97d. The revenue income was £29,443, or £616 in excess of 1902. That was highly satisfactory, in view of the fact that, by reducing the charge from 6d. to 5d., they lost about £5,000 in revenue; that concession would, however, materially assist in building up a larger business. The net result was an increase of £287 in profit. The board had transferred £1,250 to the depreciation, renewal, and reserve fund account, making a total of £17,500. The sinking fund had been fixed at 3 per cent., so that in 1931 they would receive their share of the Wood Lane cost. Comments which had been made on the sinking fund had been made on want of detailed knowledge of the various factors concerned. Suggestions had been made to the effect that the company might make great economies in working by modifying the system in certain directions. The directors were continually watching for means for economising, and not unsuccessfully, and although everyone of the proposals had been made previously, they decided to test their value by adopting them on paper. The result was that to save some £500 or £600 per annum they would be forced to spend some £30,000, as well as running risks of breakdown. The lamps added during the year were 16,863, against 17,443 in 1902. The drawback to the general use of the light was not the cost of the current so much as the outlay necessary to provide the wires and fittings. The company had experimented already with a free wiring system without success. They had now made a house to house canvass. For the first two months of this year they took in bulk from Wood Lane over 110,000 additional units, and yet the cost was considerably below that of last year. In regard to the interests of the founders' shareholders, during the period between the issue of the report and this meeting there had been a meeting of the founders' shareholders, and they had informed the board that they did not wish the suggested alteration to take place. They had therefore decided to abandon it. It had been suggested that the founders might be bought up by the issue of ordinary shares, but that course would increase the nominal capital to a figure in excess of the visible assets, and the directors thought it could not be entertained in the best interests of the company. The founders would therefore, for the present, take their old shape.

Dr. J. W. Swan seconded the motion.

There was a somewhat lengthy discussion on the subject of further reducing the works costs, and on the question of depreciation, and these matters having been replied to by one of the directors, the report was adopted.

The retiring directors and auditors having been re-elected, a vote of thanks closed the meeting.

Buenos Ayres and Belgrano Electric Tramways Co.

Mr. J. B. Concanon presided at the meeting held at 52, Moorgate Street, E.C., on April 7th. He said that the traffic receipts for the year were £164,714, and the expenses £92,369. After paying debenture and interest charges, placing certain sums to renewals, accident insurance, and so on, they were able to pay for the first time in the history of the company, 3 per cent. on the ordinary shares, and carry forward £2,479. This result was eminently satisfactory. Last year they constructed nearly 3 miles of additional line, and were now constructing 1½ miles to complete their obligations under the concessions. The capital account was over-expended by £30,000, and they would shortly be asking shareholders to take £30,000 of the £40,000 unissued 5 per cent. second debentures.

Calcutta Tramways Co.

Mr. E. C. Morgan presided at this company's meeting held at Worcester House, E.C., on Tuesday. The total working expenditure for 1903 was £55,670 as against £56,916 in 1902. The traffic receipts had increased by £25,961 over 1902, and by £41,849 when compared with 1901, which was the last and best year with horse traction. The dividend for the year amounted to 6 per cent. £12,417 had been added to the reserve fund, which the directors now proposed to entitle "depreciation fund"; that fund would be separately invested, so as to be at once available if needed. It was necessary to make as full a provision as possible, not only for depreciation as apart from efficient maintenance, but also in order to be in a position to take advantage of any important improvements which might arise in the course of electrical development. The report was adopted.

In replying to a cordial vote of thanks to the staff and to himself for his services as managing agent in Calcutta, Mr. Martyn Wells, who is home on a short holiday, said that there was no doubt as to the success of electric traction from the traffic point of view. The passengers carried last year were some eight or nine millions more than in the last year of horse traction.

Dover Electricity Supply Co.

The tenth and last annual meeting of this company was held on Wednesday last week at Dover, Sir W. H. Crundall presiding. The profit for the year had been at least 30 per cent. more than in 1902, and he hoped that it would increase in the same ratio in 1904. They had put down a fine Ferranti engine and alternator, which would effect a great saving in their coal bill, but the unfortunate part of the business was that if this engine were at any time to break down they would find themselves next winter in a difficult position, so the directors were recommending the Corporation to put down another engine of about the same power. It was expected that the transfer to the Corporation would take place about May 6th next, if the legal gentlemen and the liquidators could get everything in readiness, as the Corporation expected by that time to be in possession of the money. He considered they would hand over to the Corporation a concern that would, out of its own earnings, pay interest and capital charges without touching the rates, and he hoped to show this would be so, and with that view he trusted the Corporation would elect him on the Electricity Committee so that they could demonstrate to the ratepayers that what they had expected to do all along would come to pass. If they did this he thought everybody would say that it had been a grand bargain for the Corporation, and the concern would, practically, at the end of 35 years, be made a present to the town. The report was adopted.

Perth Electric Tramways, Ltd.

Mr. Edward Heasman presided at the meeting of this company held at 3, Laurence Pountney Hill, E.C., on Tuesday, and, in moving the adoption of the report, said that the shareholders were to be congratulated upon the steady progress of the company. The receipts showed a substantial increase over 1902, though the alteration in the mileage was comparatively unimportant. The earnings for this year (14 weeks) had been £2,756 in excess of last year's figures. They had had to provide for business which had expanded far more rapidly than they originally calculated upon, and had had to furnish more cars, car-barns, and power plant to keep pace with it. When these additions were all carried out they would effect economies in working, and that fact, together with the prospect of further increases in the traffic receipts, justified them in looking for greater prosperity for the company in the immediate future. They had placed £6,000 to reserve as a prudent course. The track had been maintained in a high state of efficiency, but in the course of time repairs to and renewals of plant, track, cars, &c., would be needed, and they wished to be able to deal effectually with these matters without disturbing the existing arrangements by having a substantial reserve gradually built up. Nothing would have given the board greater pleasure than to have paid a dividend to the ordinary shareholders, but they thought that as business men they had adopted the proper course. The passing of the Tramways Amendment Act of 1903 would enable the company to substitute a double line, subject only to the approval of the local authority, thus avoiding the tedious practice of applying specially to Parliament. Mr. E. E. Rogers, who had been for six years managing director of the company in West Australia, had retired. A local board had been appointed to assist the manager and engineer in the management of local affairs.

Mr. Wetherbed seconded the motion, and it was carried.

Indo-European Telegraph Co.

The directors' report for 1903 reads:—

Further reductions in tariffs have been introduced in connection with the Telegraph Conference. The company's foreign concessions have all been extended up to the end of 1924. Terms of the agreement for the leasing of land lines in this country and submarine cable wires from Lowestoft to the German coast have been agreed between the Postmaster-General, the Imperial German Post Office, and the company, and the detailed agreement is now in course of preparation. The lines of the company continue to work efficiently, and the direct Wheatstone working between London and Teheran, which has been completely satisfactory, has been extended to Manchester and Liverpool. The shareholders were informed in the last report of the directors that it had been agreed to refer to arbitration the question of the incidence under the Cis-Indian joint purse of certain higher "paid-outs," for which the company is liable under its extended concessions. The directors are pleased to inform the shareholders that the award was substantially in favour of this company. In consequence of this award, a certain sum, provisionally retained on suspense account, is now released. The shareholders were informed in the last report that the directors proposed to introduce a retirement scheme for the officers and general staff of the company. The scheme has now assumed definite shape, and has been in operation since October 1st, 1903. The directors now propose to allocate to the purposes of this scheme the sum mentioned above as available in consequence of the arbitration award, namely, £12,394 10s. 9d., and trust that this course will commend itself to the shareholders. A fund was provisionally established at the last general meeting of shareholders for the purpose of the retirement scheme, and the directors propose, at an extraordinary general meeting of which separate notice is given, to ask for the consent of the shareholders to an alteration in the articles of association to enable them to form a trust fund, and to hand over to the trustees of such fund, the sum of £5,000 voted by the shareholders last year (with interest at 3½ per cent.), the sum of £12,394 now proposed to be voted (also with interest at 3½ per cent.), and any sums to be voted hereafter. The company's revenue from all sources for 1903 amounted to £139,094, as compared with £134,305 for 1902, showing an increase of £4,789. The expenses were: on commercial and general account, £42,443; on maintenance account, £26,450; total, £68,894, as against £64,352 for 1902, an increase of £4,542. Deducting the above expenses of £68,894 from the total revenue of £139,094, a balance remains of £70,201, from which income-tax paid £3,542 has to be deducted, leaving £66,659. To this has to be added the amount brought from the year 1902 of £17,207, and £12,394 held in suspense and now transferred, being available in accordance with the award in the Cis-Indian Joint Purse Arbitration, making a total of £96,260. From this sum has to be deducted the interim dividend of £10,625, leaving an available balance of £85,625. The directors now propose to add £15,000 to the fund for the equalisation of dividends; to hand over, as proposed above, £12,394 to the retirement trust fund to be formed; to write off a further sum of £10,000 for depreciation of reserve fund investments, and to declare a dividend for the six months ending December 31st, 1903, of 17s. 6d. per share (making, with the dividend already paid, 6 per cent.), and a bonus of 2s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £16,365 17s. 3d. to the credit of 1904.

Anglo-Argentine Tramways Co.

The Chairman of this company informed his shareholders the other day that the adoption of electric traction had caused the receipts to increase from £254,582 to £328,994 during the year 1903. On the other hand, the working expenses had decreased by £16,700, so that the net income was £91,000 greater than for 1902. The company had, under its agreement with the Argentine Electric Co. (by whose assistance the conversion had been made possible), given that company shares of the value of £850,000. We make the following interesting quotation from the chairman's speech:—

It is now between five and six years ago that we were first approached on the question of the conversion of this tramway. Naturally, it was rather a big consideration. The company not having been very successful in the past, the finding of such a large sum of money as £800,000 to £1,000,000 was a very serious matter for us to undertake, especially as we had issued the bulk of our 6 per cent. debenture stock, that the income we had to divide amongst the ordinary shareholders was barely sufficient to pay 4 per cent. per annum, and that the price of the shares was 3¼. Under the circumstances, you will understand that the raising of so large an amount of additional capital was a matter of great anxiety to us, however much we might be tempted to carry it through, by the experience of other companies. Then the Argentina Electric Traction Co. came and said, "We will find you the money, and allow your shares to be a preference over our outlay—a preference which shall be cumulative." Though we were rather averse to the risk of the whole thing, we felt that these terms were so favourable that we ought to ask you to adopt them. Well, you did adopt them, and what is the result? Why, over and above the income which it is necessary for you to pay to the ordinary shareholders, representing £65,000, there is a sufficient balance to allow us to place the substantial sum of £15,000 to reserve and depreciation, carry forward £6,220, and declare a dividend of 6 per cent. on the ordinary shares which have been created to represent the money which the Argentina Traction Co. has spent on our undertaking.

The meeting voted a sum of 2,000 guineas to the chairman (Mr. H. Doughty Browne) for special services rendered during the conversion to electric traction.

Thames Iron Works, Shipbuilding and Engineering Co., Ltd.

At the meeting on the 11th inst., Mr. A. F. Hills, the chairman, said that the position of the electrical engineering department had improved. A good many orders had been received from the Admiralty for auxiliary electrical equipment, and the contracts in hand were four times as large as at the same date 12 months ago. The civil engineering department had been kept busy, to a considerable extent, with the Admiralty contracts for the caissons for the new docks at Gibraltar and Keyham. This department had been extended and electrically equipped, and its output last year was greatly in excess of that of any preceding 12 months. His experience went to show that the success or failure of extensive works nowadays depended, to no small extent, upon the size of the output. If they had a wages sheet of, say, £300,000 a year, the charges were brought down to a point that did not materially interfere with their getting work, in spite of the competition which had to be faced, but, if the contracts in hand were only small, the effect on the company's position at once became unfavourable. It was for this reason that the board had been endeavouring at small expense—because they did not want to add to the capital expenditure—to enlarge the power of output at the works, and, in doing this, he believed that they were consulting the best interests of all concerned. The question of the construction of large gas engines was receiving consideration.

Merthyr Electric Traction and Lighting Co.

The directors' report for 1903 states that the gross receipts of the light railways amounted to £10,580, and the gross receipts on account of electrical supply to £3,469, making, with £59 sundry receipts, a total of £14,108. After deducting expenses amounting to £11,599 and adding the balance brought forward, viz, £177, there remains £2,687 available for distribution. The directors recommend that this amount be applied as follows:—Dividend on preference shares, £1,500: to reserve and depreciation fund, £250; dividend on the ordinary shares at the rate of 2½ per cent. per annum, £750; leaving to be carried forward, £187.

Mr. W. L. Madgen presided at the meeting of the company held at Donington House on 8th inst. He said that the actual increase in receipts was not yet very marked, but there had been a considerable reduction in working expenses. Under average trade and weather conditions both the tramways and electricity supply departments should yield better results in the near future.

Mr. G. R. Hulme seconded the adoption of the report, and it was carried.

Deutsch-Atlantische Telegraphen Gesellschaft.

The report of the German Atlantic Telegraph Co., of Cologne, states that the cable traffic during 1903 was approximately of the same extent as in the preceding year, and, although business was quiet in the first half, a recovery took place in the concluding four months. The accounts show a surplus of £78,267 as compared with £74,555 in 1902. The former total has been arrived at after meeting working expenses, interest charges and cost of cable repairs, and placing £12,383 to the cable redemption and renewal funds as against £12,396, and after writing off £2,601 for depreciation of cable stocks as compared with £1,955 in the previous year. It is proposed to pay a dividend at the rate of 5½ per cent. as against 5 per cent. in 1902. The report states that the manufacture of the duplicate cable for the Emden—Fayal section was completed last April; the work of laying was finished in September, and the section from Borkum to the Azores has been in operation since October, the speed of transmission being more rapid than with the first, or 1900, cable. According to the agreement with the Imperial Post Office authorities, the company will receive a subsidy of £37,500 for 1904 as a result of the opening of the first section of the duplicate cable to traffic. With regard to the second section from Fayal to New York, the report mentions that the North German Cable Works Co. had completed 1,430 knots by December 31st, and it is expected that the manufacture of the remainder has now been finished, so that the cable steamer *Stephan* may proceed with the work of laying during April. The company proposes to fulfil its obligation to take over the Vigo cable at the end of December of this year by the acquisition of the shares of the German Marine Telegraph Co. The sum of £150,000 required for this purpose will be provided by calling up the unpaid capital on the "F" series of shares.

Potteries Electric Traction Co.

The directors' report for the year ended December 31st, 1903, shows that the gross receipts amounted to £97,702. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on loans and debenture stock, there remains a profit of £26,258. To this has to be added £851, brought forward from the previous account, making an available balance of £27,109 11s., which is to be applied as follows:—

Depreciation and reserve fund	£2,000	0
Dividend for the year on the 5 per cent. cumulative preference shares	12,093	15
Dividend on the ordinary shares of the company (5 per cent.)	12,249	10
Carry forward	766	6
	£27,109	11

In April last an issue was made of 2,500 ordinary shares and 2,500 preference shares of £10 each. Arrangements have been made for an issue of £25,000 debenture stock at an early date, to provide for the completion of works now in hand. The capital expended during the year on the doubling of the Fenton section of the main line, and on the construction and electrical equipment of the light railway between Newcastle and Stoke, and on Maybank power house, cars and car-sheds, &c., amounted to £33,960 15s. The capital expenditure during the year has only quite lately become remunerative, the doubling of the line at Fenton having been completed in November last, and the Newcastle to Stoke light railway having been opened for traffic on February 23rd this year. The directors are able, however, to recommend the payment of the same dividend on the ordinary shares as in the previous year, though on a larger capital. The parcels express delivery has been working satisfactorily during the year, and the receipts from this source show a material increase.

Miles Open—	Year ended Dec. 31st, 1902.	Year ended Dec. 31st, 1903
Route miles	28·95	28·95
Single line	22·95	21·79
Double line	6 0	7·16
Number of passengers carried	14,438,048	14,934,069
Average traffic receipts per passenger	1 32d.	1 33d.
Average expenditure per passenger	0·78d.	0·79d.
Proportion of expenses to receipts	59 %	59 %
Number of cars in stock	105	105

Mr. G. F. M. Cornwallis West presided at the meeting at Hamilton House on the 8th inst. He referred to certain peculiar difficulties of the year, notwithstanding which they were paying the same dividend as in the previous year, carrying a similar sum to depreciation, and the carry forward was only £78 less. Several new routes had lately been completed and were now earning

revenue. Bad weather, bad trade, and increased rates were features of the year. Owing to the present state of the money market the company must keep all capital expenditure down. The company's experience with its parcels traffic showed that such a service, properly organised, tramway companies could meet with profit and success, a long felt want in thickly populated districts. Mr. Garcke seconded the adoption of the report and it was carried.

Birmingham and Midland Tramways, Ltd.—The report for the year 1903 states that the total revenue amounts to £86,399, and, after deducting expenses chargeable to revenue, including repairs, maintenance, and interest on debentures, there remains a profit of £19,652. Deducting the dividend on the preference shares and adding the amount brought forward, there remains an available balance of £21,409. The directors propose to place to depreciation and reserve fund the sum of £9,000, to pay a dividend on the ordinary shares (since converted to 7 per cent. preferred ordinary shares) at the rate of 6 per cent. for the year ended December 31st, absorbing £11,714, and to carry forward £695.

Angus Electric Light and Power Co.—This company (of Montrose and Brechin) reports that 1903 was a very satisfactory year. In Montrose the increase in the number of lamp connections was from 6,422 to 11,670 8-c.p., while in Brechin it was from 5,725 to 7,359. In addition, 1,500 additional lamps had been applied for in Montrose, and 2,000 in Brechin, making a total of 22,529 for the two towns. During 1903 a profit of £2,152 16s. 2d. was made, including the sum of £418 10s. 9d. brought forward from last year's account, and on deducting interest to the amount of £918 3s., a balance of £1,234 13s. 2d. remains available for distribution. The directors recommend that a dividend of 2½ per cent. be declared, and that £500 be placed to reserve and renewal fund account, leaving a balance of £469 13s. 2d. to be carried forward.

Babcock & Wilcox, Ltd.—The report for 1903 states that the net profit during the year, after deducting depreciation on plant, &c., amounts to £180,043. To this has to be added the balance brought forward, £17,878, making £197,921. The directors recommend a final dividend of 8 per cent. on the ordinary shares, making 15 per cent. for the year and a bonus of 2 per cent. on the ordinary shares, placing to the reserve fund £50,000 and to dividend equalisation fund £25,000 leaving a balance of £26,821 to be carried forward.

Electro-Peat Coal Co.—The statutory meeting of this company was held at Cannon Street Hotel, on the 8th inst. The chairman, Mr. Rowe, made a statement about the company's achievements with the Belsey process since its formation, and said that it was not too much to expect that as many as 200 subsidiary companies would be formed from the parent company within the next two or three years.

Stock Exchange Notices.—The Committee has appointed a special settling day as under:—Wednesday, April 20th. Consolidated Electrical Co., Ltd.—109,251 ordinary shares of £1 each, fully and partly paid, Nos. 1 to 109,251, and has also ordered the undermentioned securities to be quoted in the Official List:—Bath Electric Tramways, Ltd.—59,394 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 59,394; and 75,606 preferred ordinary shares of £1 each, fully paid, Nos. 75,001 to 150,606.

Anglo-American Telegraph Co.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1904, of 12s. 6d. per cent. on the ordinary stock, and £1 5s. per cent. on the preferred stock, less income-tax, payable on April 30th.

Oriential Telephone and Electric Co.—The directors recommend the payment of a dividend at the rate of 6 per cent. per annum on the preference shares for the period ended December 31st last, less income-tax, and a final dividend of 3½ per cent. on the ordinary shares, free of income-tax, making a total of 6½ per cent. for the year.

Northwich Electric Supply Co.—An extraordinary meeting of shareholders has been called to authorise the transfer of the undertaking to the Cheshire Electricity and Power Gas Co.

STOCKS AND SHARES.

Wednesday Evening.

For the wave of fresh confidence and higher prices that is sweeping over the Stock Exchange, the reasons are almost too well-known to require fresh enumeration. Briefly put, they may be chronicled as prospects of cheaper money, the new Anglo-French agreement, the advent of better times in the Transvaal, the unloosing of deposit accounts from the keeping of the banks, and a dozen other causes that are influenced, more or less directly, by these four factors. Financial houses of all kinds which are holding various classes of stock find that there is a new demand for their wares, and, wisely enough, they are not eager to sell at the current quotations. Add to this the established certainty that dealers have not been carrying any large amounts of stock on their books for some time past, and here are two immediate, tangible reasons why a yet comparatively small public demand should have had such an electric effect upon prices in the general markets.

Electrical departments so far have failed to receive any appreciable benefit from the better tone. They are, as a rule, too far from the beaten track trodden by the average investor, for their quotations, either to suffer very much, or to greatly improve under the compulsion of passing events. The decline of the past 12 months, however, has been considerable, quietly effected as it was, and there is fair ground for the supposition that Supply shares, for instance, will advance in price with other markets, assuming that the present cheerful tone is not only maintained, but extended. These are early days to expect any rise worth mentioning in Electricity Supply issues, and the only noticeable advance this week falls to Brompton and Kensington shares. The Ordinary are ¼ harder at 10¾, while the Preference show a 10s. gain at 10½, which follows upon the recovery of the dividend in the price a week ago. Urban Ordinary and Preference have both fallen ½ to 4⅜ and 4⅞ respectively. In the prior charge list London Electric Debenture has lost its recent slight gain of a point, and Edmundson's Debenture is up 1 to 105½. Except for these alterations, the list shows no quotable change.

Telegraph descriptions have a different tale to tell. Out of about a score of changes only one is against holders, and that is a drop of 5 in Commercial Cables, on the new competition lately inaugurated. The price is now 180. Anglo-Americans show a rise of ¼ in the Deferred, although the dividend announcement is not liked by any means. The reduction to 25s. per cent. for the quarter on the Preferred stock was, however, anticipated by the dealers. Direct United States have recovered their dividend at 10½. There is a much firmer feeling among the Eastern varieties, "China" shares being up another ¼ to 11½, and Eastern Ordinary having jumped three points to 122½. Indo-European shares are £2 harder at 41½ on the report; the idea, too, is current that the trouble in Thibet may be good for the company's traffics, while, of course, the Eastern group owes much of its firmness to the hope that, with Chinese labour, our new Colonies will make those industrial strides whose delay in coming has caused so great disappointment since the end of the Boer war. Submarine Cables Trust are 3 up at 120½, while Globe Ordinary and Preference have risen ¼ each to 8½ and 12½. Western Telegraphs are ¼ harder at 12½, the Debenture stock also hardening. Commercial Cable Debenture, notwithstanding the flatness of the Common, shows a point improvement at 91, and several other Debentures have advanced to a small extent.

In the telephone market, Orientals at £1 are 1s. 3d. better, and the only advance amongst the National Co.'s stocks is one of a point in the Deferred to 87, and of 2 per cent. in the 3½ per cent. Debenture, which now stands at 98. The first and second Preference shares are again lower at 11 for both classes, the course of the prices bearing out our arguments that the shares are much too high at £14 apiece. The other issues have not altered.

Again the Electric Railway list is tamely quiet. Waterloo and City has hardened a little to 90½, thanks to a small improvement in London and South-Westerns, but the Central London and the City and South London group remains merely steady. Central Londons are perhaps firmer than they appear from the prices. Yet the steam stocks are all decidedly better. Metropolitans have climbed to 91, and Districts spurted to 35¾, the advances being 3½ and 2 respectively. Great Northern and City Preferred stick at 6, but some of the unfavourable criticism levelled at the company's progress takes no note of season tickets or of the probable expansion in receipts. After making all allowances, however, it must be admitted that the expectations of bumper traffics are still very far from being realised at present. East London has improved to 4⅞, but Mersey stock is a shade easier at 7½.

After their improvement last week, British Electric Traction Preference have slipped back ½ to 10½, but the Ordinary remain at 9, rather buyers at the time of writing. London Street Tramway shares are 1 to 1¼, and Perth Electric Tramway Debenture has been done at 101 and 100½, the difference probably representing a jobber's turn. Potteries Debenture stock marked 100¼ in Tuesday's Stock Exchange Official List, although the nominal price is 103 to 106. Has anyone nodded? The new Metropolitan Tramways Debenture stock is being negotiated at about 2½ to 1½ discount, so that our remarks of a fortnight ago upon the outlook for the quotation were not unjustifiably pessimistic. London United Tramways descriptions are steady, without alteration in price. Willans and Robinson Ordinary continue dull at 2, and the Preference are 4, after being easier. Babcock & Wilcox have hardened upon the excellent character of the report.

Bank Rate Altered.—The Bank rate was yesterday reduced from 4 to 3½ per cent.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations April 6th.	Closing Quotations April 13th.	Business done week ended April 13th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	98	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2¼— 3½	2¼— 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	.. — ..	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	48 — 51	48 — 51	..	..
3,105,880	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92½	91
3,105,880	Do. do. do. Deferred	Stock	2s.	1/-	2s.	6⅜— 7⅛	7⅛— 7⅜	7 7/16	7⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4⅜— 5½	4⅜— 5½	..	..
15,333,300$	Commercial Cable	$100	8 %	8 %	..	180 —190	175 —180	175	..
1,841,300	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 91 xd	90 — 92	91½	91
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7½— 8½	..	..
6,000	Do. 10 % Pref.	10	..	..	..	15½— 16½	15½— 16½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2½— 3½ xd	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	99 —102	99 —102	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	9⅜— 10½ xd	10 — 10½	..	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	117 —122	120 —125	121¾	119½
1,955,565	Do. 5½ % Pref. Stock	100	..	..	..	86 — 89	86 — 89	..	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	11 — 11½	11¼— 11⅞	11⅞	11⅛
830,000£	Do. 4 % Deb. Stock	Stock	..	..	..	103 —106	103 —106	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —103	100 —103	..	..
180,227	Globe Telegraph and Trust	10	5½%	..	..	8 — 8½	8¼— 8⅝	8¼	8
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 12½	12¼— 12⅝	12 7/16	12¼
160,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	25 — 26	25 — 26	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	10 %	38 — 41	40 — 43	41¾	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	103 —105	103 —105	104¼	102½
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	85 — 87	86 — 88	87⅛	84½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	10 — 12	10½	10⅜
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	10 — 12	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅞— 5⅛	4 15/16	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 97	97 — 99	98	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	99 —101	100 —102	100½	97½
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	7/8— 1	15/16— 1 1/16	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6⅞— 7⅛	6⅞— 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	115 —120	118 —123	119	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾— 6	5¾— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅝— 5⅛	4⅝— 5⅛	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	97 — 100	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	11¾— 12¼	12 — 12½	12 1/16	12¼
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	99 —102	..	..
88,821	West India and Panama Telegraph	10	..	..	..	3/8— 3/4	3/8— 3/4	3/8	..
34,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	5¾— 6¼	5¾— 6¼	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4¼— 5¼	4¼— 5¼	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4 — 5	4 — 5	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	89 — 94	90 — 95	9 5/16	8 7/8
100,000	British Electric Traction	10	9 %	8 %	..	8½— 9½	8¾— 9¾	11	10⅛
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10⅜— 11½	10½— 10⅞	..	..
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	116 —119 xd	116 —119	118	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	5⅞— 6⅛ xd	6 — 6⅛	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	6⅛— 6⅜	6⅛— 6⅜	..	..
60,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	3/8— 7/8	3/8— 7/8	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	1/4— 3/8	1/4— 3/8	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	1/4— 1½	1/4— 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	96 — 99	96 — 99	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	72 — 77	72 — 77	..	..
85,000	Callender's Cable Construction shares	5	20 %	15 %	..	10½— 11½	10½— 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 5⅝	5¼— 5⅝	5½	5
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	90 — 93	90 — 93	94	93
494,998	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	98 —101	..	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	85 — 88	85 — 88	86	85
1,880,000	City and South London Railway	Stock	2 %	3½%	2⅔%	49 — 52	49 — 52	50½	50
85,000	Crompton & Co., Nos. 1 to 85,000	5	7½%	5 %	..	1½— 2	1½— 2	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	96 — 99	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	0 — 1/4	0 — 1/4	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	1/2— 1½	1/2— 1½	..	..
844,028£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	74	73½
100,000£	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	74 — 79	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1½— 1⅝	1½— 1⅝	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	..	..	..	2½— 3	2½— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9 — 9½	9 — 9½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	93 — 98 xd	93 — 98	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	11½ — 12½ xd	11¾— 12⅜	11 13/16	..
200,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5½	5 — 5½	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18 — 19	18 7/16	18⅜
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102 xd	99 —102	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅛— 4⅜	4⅛— 4⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	9½— 10½	10 — 10½	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	33 — 36	34 — 37	34	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	88 — 91	89 — 92	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years			Closing Quotations April 6th.	Closing Quotations April 13th.	Business done week ended April 13, 1904.	
		†	1901.	1902.	1903.			Highest.	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅜ — ⅞	⅜ — ⅞	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1⅛ — 1⅜ xd	1⅛ — 1⅜	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	113 —116 xd	113 — 116	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10¾ — 10¾ xd	10¼ — 11	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9¾ — 10¼ xd	10¼ — 10½	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	106 —109	106 —109	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7 — 7¼	7 — 7⅛	7⅜	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5¼ — 5¾	5⅛ — 5⅜	5¼	..
45,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4¾ — 5	4⅝ — 5	..	..
40,000	Do. do. 1903	5	..	..	..	4¾ — 5	4⅝ — 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	102 —104	102 —104	103	..
44,436	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	5¼%	6 — 6¼ xd	6 — 6¼	6¼	..
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	5 %	10¼ — 10¾	10¼ — 10⅜	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	..	..
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7 — 8 xd	7 — 8	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11 — 12	11 — 12	..	..
400,000£	Do. do. 4½% Deb. Stock	..	..	..	..	106 —109	106 —109	107⅛	106⅝
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	100⅛	99⅝
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5⅞ — 6¼	5⅞ — 6⅛	6 1/16	5 15/16
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	5¾ — 6¼	5¾ — 6⅛	6 1/16	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	103 —106	104 —107	105¼	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	12½	11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104 xd	103 —106	103½	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1 — 1¼	1 — 1¼	1⅛	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4¼ — 5	4¼ — 5	4⅝	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	94 — 97	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6⅔%	7⅓%	8⅓%	18 — 19 xd	18 — 19	18⅛	18⅜
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5⅛ — 5⅜ d	5⅛ — 5⅜	5 5/16	5⅛
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	111½	..
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
10,859	Notting Hill Electric Lighting	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
50,000	Do. do. 4 % First Mort. Debs.	100	..	..	..	99 —102 xd	99 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14⅓%	14⅓%	14⅓%	14 — 15	14 — 15	14⅔	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000£	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	3 3/32	3⅛
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1⅔%	3 %	3 — 3½	3 — 3½	3 7/16	..
30,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜ — 5 xd	4⅜ — 4¾	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4¾ — 5¼ xd	4⅜ — 5	..	..
110,000	Westminster Electric Supply, Ord.	5	10⅓%	12 %	13⅓%	12⅜ — 13⅛	12⅜ — 13⅛	12⅞	12⅝
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½	..	..

*Subject to Founders Shares. † Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, April 13th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	„ Nitric	per cwt.	22/-	..
a	„ Oxalic	per cwt.	35/-	..
a	„ Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	„ „	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90 %)	per gal.	7/-	..
a	„ (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£21 10	30/- dec.
a	Lead, Nitrate	per ton	£24	..
a	„ White Sugar	per ton	£31	..
a	„ Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	3d.	..
a	„ Caustic (75/80%)..	per ton	£24	..
a	„ Bisulphate	per ton	£35	..
a	Shellac	per cwt.	218/-	10/- inc.
a	Sulphate of Magnesia ..	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	„ Recovered	per ton	£5 10	..
a	„ Lump	per ton	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a	„ Crystals	per ton	£8	..
a	„ Bichromate, casks.. ..	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	„ Wire, in ton lots ..	per ton	£168	..
b	„ Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £130	..
c	Brass (rolled metal 2" to 12") basis	per lb.	6⅝d.	..
c	„ Tube (brazed)	per lb.	8⅞d.	..
c	„ „ (solid drawn).. ..	per lb.	7⅞d.	..
c	„ Wire, basis..	per lb.	7d.	..
c	Copper Tubes (brazed)	per lb.	9¼d.	..
c	„ „ (solid drawn) ..	per lb.	9⅞d.	..
g	Copper Bars (best selected ..	per ton	£72	..

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£72	..
g	„ Rod	per ton	£72	..
e	„ (Electrolytic) Bars ..	per ton	£64	..
e	„ „ Sheets ..	per ton	£80	..
e	„ „ Rod ..	per ton	£74	..
e	„ „ H.C. Wire	per lb.	8d.	..
f	Ebonite Rod	per lb.	3/3	..
f	„ Sheet	per lb.	3/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	3/-	..
h	India-rubber, Para fine	per lb.	4/7 to 4/8	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	„ Pig (Cleveland warrants)	per ton	44/8	1d. dec.
i	„ Forgings, according to size	per ton	From £11	..
i	„ Scrap, heavy	per ton	47/6 to 50/-	..
i	„ Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£12 10	dec.
g	„ „ Sheet	per ton	£13	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£8 5	..
d	Mica (in original cases) small ..	per lb.	6d. to 1/9	..
d	„ „ medium	per lb.	2/6 to 4/-	..
d	„ „ large ..	per lb.	4/6 to 8/6	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/3½	..
p	„ rolled bars & rods	per lb.	1/- to 1/8	..
p	„ „ strip & sheet	per lb.	From 1/1	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 11d.	..
j	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	„ in bars		£15 to £40	..
g	Tin, Block	per ton	£128 10	dec.
g	„ Foil	per lb.	1/6	..
n	„ Wire, Nos. 1 to 16	per lb.	1/7	..
p	White Anti-friction Metals—			
	"White Ant" brand ..	per ton	£42 to £62	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	„ 6 lea. Flax	per lb.	5½d.	..
j	„ 8 ply 10 lbs. Russian ..	per lb.	4½d.	..
j	„ 10 lbs. Russian, single ..	per lb.	4½d.	..
j	„ 180 lbs. Jute rove ..	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

	Locality.	Week ending	Receipts for the week.		No. wks.	Total to date.		Miles open.	
			£	£*		£	£*		*
	Aberdeen	Apr. 9	1,206	+272	45	54,079	+10,907	10	—
	Birmingham ..	„ 9	6,153	+1120	15	77,383	+ 4,256	31½	—
	Bournemouth ..	„ 6	1,565	+715	52	52,445	—	10½	—
	Blackburn	„ 8	1,122	+ 64	2	2,180	+ 650	13½	—
	Blackpool	„ 7	1,445	+1069	1	—	—	8½	—
	„ —Fleetw'd	„ 9	631	+ 49	15	3,404	+ 84	7½	—
	„ —Lytham	„ 7	601	—	23	8,886	+ 3,807	7½	—
	Bolton	Mar. 27	1,618	— 68	52	93,216	+ 8,798	25	—
	Bradford	„ 31	1,938	+141	52	194,910	+25,267	47	—
	Brighton	Apr. 10	980	—	—	1,462	—	7½	—
	Bristol	„ 8	5,782	+1010	—	—	—	28	—
Co.	Devonport ..	„ 1	520	+ 88	13	5,933	+ 864	5	—
Trac.	Dudley—Sto'rb'ge	„ 1	791	+ 11	13	9,549	+ 406	18½	—
Elec.	Gateshead ..	„ 1	910	+ 54	13	11,211	+ 654	10½	+ ½
	Gr'n'k—Pt. Glsgw	„ 1	478	— 18	13	6,031	+ 597	7½	—
Br's.	Hartlepool ..	„ 1	275	+ 13	13	3,198	+ 352	6½	+2
	Oldham—Ashton	„ 1	595	+ 57	13	6,420	— 317	8	—
	Potteries	„ 1	1,702	+138	13	21,264	+ 1,558	28½	—
	Southport	„ 1	301	+ 49	13	3,111	+ 274	5½	—
	South Staffs. ..	„ 1	748	— 57	13	9,535	+ 275	21½	—
	Swansea	„ 1	518	+ 72	13	5,950	+ 218	5½	—
	Wolverhampton..	„ 1	849	— 22	13	4,908	— 199	10½	+8
	Yorks. Wool Dist.	„ 1	557	+351	13	6,592	+ 2,521	6	—
	Miscellaneous ..	„ 1	2,973	—	13	34,762	—	—	—
	Burnley	„ 9	971	— 57	—	—	—	10·15	+2·4
	Burton-on-Trent ..	„ 10	363	—	36	12,100	—	8½	—
	Cardiff	Mar. 26	1,815	+127	—	100,453	+28,428	1	—
	Chatham & District	Apr. 7	773	+281	14	7,203	+ 1,367	8·53	—
	Cork	„ 7	462	— 17	14	5,471	— 147	9	—

* Compared with the corresponding period of 1903.

	Locality.	Week ending	Receipts for the week.		No. wks.	Total to date.		Miles open.	
			£	£*		£	£*		*
	Dover	Apr. 9	246	— 1	14	2,498	— 122	3	—
	Dublin	„ 8	4,936	+376	15	61,195	+ 862	47	+ ½
	East Ham	„ 9	833	+110	—	1,105	+ 72	5	+ ½
	Glasgow	„ 9	14,015	+777	45	610,693	+56,836	69½	+5
	Halifax (2 weeks) ..	„ 6	3,003	+731	1	1,672	+ 399	33	+2½
	Huddersfield ..	„ 9	1,546	+360	52	65,545	+ 8,914	28	—
	Hull	„ 9	2,218	+211	1	2,956	— 153	12½	+1½
	Ilkeston	„ 6	157	—	—	—	—	3½	—
	Ipswich	„ 9	524	—	—	726	—	9	—
	Isle of Thanet ..	„ 9	596	+ 13	14	3,749	— 235	10½	—
	Leeds	„ 9	6,185	+827	—	12,612	+ 2,139	41	—
	Liverpool	„ 2	9,933	+248	14	133,121	+ 3,223	108	—
	London C. C. ..	„ 9	11,770	+2726	—	15,864	+ 3,662	39¾	—
	Manchester	„ 9	12,127	+ 64	1	—	—	131½	—
	Newcastle	„ 9	3,791	+ 454	—	—	—	17	—
	Portsmouth	„ 9	2,468	+616	—	3,169	+ 486	14½	—
	Salford	„ 4	4,377	+1236	—	2,769	+ 59	30	—
	Sheffield	„ 10	4.887	+410	2½	10,692	— 497	32½	+4½
	Southampton ..	„ 7	1,074	+166	—	—	—	25½	—
	Southend-on-Sea ..	Mar. 20	211	— 3	52	15,643	+ 2,247	6	—
	Sunderland	Apr. 10	1,249	+ 25	2	1,771	— 248	20	+8
	Tyneside	„ 6	422	+150	14	4,027	+ 745	8·9	+ ·43
	West Ham	„ 7	807	—	6	2,113	—	4·66	—
	Wolverhampton ..	„ 6	705	+292	—	—	—	7·563	—
	Cen. London Rly. ..	„ 9	6,673	—160	15	104,795	+ 819	6	—
	City & S. Lon. Rly.	„ 10	2,922	+109	15	46,240	— 811	6½	—
	Dublin—Lucan Rly.	„ 10	144	+ 18	15	1,403	+ 103	6½	—
	L'pool Overh'd Rly.	„ 10	1,776	+ 91	15	28,113	+ 349	6½	—
	Mersey Railway ..	„ 9	1,651	+ 549	14	20,305	+ 5,174	4½	—

INSTITUTION OF ELECTRICAL ENGINEERS.

LOCALISATION OF FAULTS ON LOW-TENSION NETWORKS.

By W. E. Groves, Associate Member.

(*Paper read at Birmingham, March 16th*, 1904.)

(*Continued from page* 605.)

The writer has found the induction method of fault localisation very satisfactory. It is more definite in its indications at one time than another, and nearness of other mains or pipes running parallel is an embarrassment. At the same time, the exact position of a fault has been indicated on a cable surrounded by a large number of live cables, and where a satisfactory result was to be least anticipated. An explanation of this and occasional converse cases would be of the greatest interest. Complete failure with single conductor cables is, in the writer's experience, almost unknown.

It is well, when a faulty line is localised, to thoroughly inspect the surface and open up any suspicious points where there have been recent excavations for any work in connection with the laying of other mains, pipes, or for executing road repairs or alterations. Much time and labour may be often saved in this way.

If the coil indicates a certain point, it should be ascertained whether a service or T joint is taken off at such point, and if there is the coil will, of course, be taken along the branch line.

If the telephone beat "tapers off," the fault is to be looked for where the "taper" commences.

It is of the greatest importance that particular care be taken to note any deviations in the cables when the coil is being taken over the route. Dips in the main at road-crossings, &c., are to be carefully taken account of.

It is, of course, desirable to have the coil as light as possible; consequently the beat will be no louder than is necessary.

As the distance from the cable under test affects the beat of the receiver, a deviation (which should certainly be found on the mains plans) has naturally the same effect on the telephone if the coil does not follow it as a true indication when the coil is over the fault.

The loudest beat is not always the best. It is often accentuated by induction in parallel conducting media. It is sometimes necessary to earth artificially all mains and armourings running parallel to get satisfactory indications. There is no rule, and it is always well to try the test without earthing precautions in the first instance. It is as likely to succeed as not, and, if successful, time and labour are saved.

The localisation of faults by the exploring coil when armoured or lead-covered cables are employed is generally more troublesome than with single-core cables without metallic sheathing, by reason of the misleading effects of induction before referred to.

If a fault is partially localised on either outer, but cannot be eliminated before dark, the main may be cross-coupled in the nearest junction box, making the faulty cable neutral. This should preferably be done through a fuse, in order that the recording ammeter and earth resistance may not be cut out in the event of a bad fault turning up on either outer.

There is risk of breaking lamps on the crossed circuit, but it is better to take this risk for a few hours than put many consumers in darkness. The meters of some consumers will also be temporarily reversed, but extinction is always the greatest evil, and the reputation of the supply business is of more value than the units unrecorded or cancelled by the meters.

Exception may be taken to the rather free manipulation of the earthing switch. Although it should be left alone as far as possible, and always controlled by a spring to prevent its being inadvertently left open, it should never be allowed to interfere with the ready detection and elimination of faults. It is also essential for the continuity of supply that the earth connection should be made through a resistance, as mentioned above, for reasons too obvious to need repetition.

The frequent checking of the soundness of the neutral is the key to the proper maintenance of insulation. Neutral faults, not being self-apparent, accumulate if means are not taken to detect them until the recording ammeter and resistance are effectually shunted. This would create a "fools' paradise," to be followed sooner or later by a "rude awakening."

The various localisation tests, such as are fully described in Raphael's "Localisation of Faults," have not been touched on—it would be difficult to elaborate on them. They are excellent in their way, but there are practical difficulties in the use of sensitive instruments on supply mains, and the writer prefers to localise leakage faults by means of the exploring coil, and thinks it will generally be found the most expeditious method, except sometimes when armoured or lead-covered cables are under test. In the event of a "short" which has not "grounded," some text-book method of localisation must be employed.

In concluding this account of rough and ready, but practical, methods of fault detection and removal, the writer ventures to hope the subject may be considered of sufficient importance and general interest to provide material for an interesting discussion, to which he looks for much information and instruction.

Appendix I.

Fig. 7 shows a network box fitted with three types of blocks, as mentioned above, for (1) connecting solid, (2) fusing, or (3) isolating distributors or branches. In the illustration the distributors coming from feeder 1 are shown connected solid by means of the block B. The distributor from feeder 2 is connected by a fuse block A, and that from feeder 3 is isolated by the block C. The last-named block is inserted to hold the cables rigid to the bar, and thus prevent any sinking and displacement of the centres should the cables be left disconnected for a long period.

The fuse block A is shown with the body constructed of vulcanised fibre. This is a convenient material, but if heavy currents are passing normally, an entirely non-inflammable material

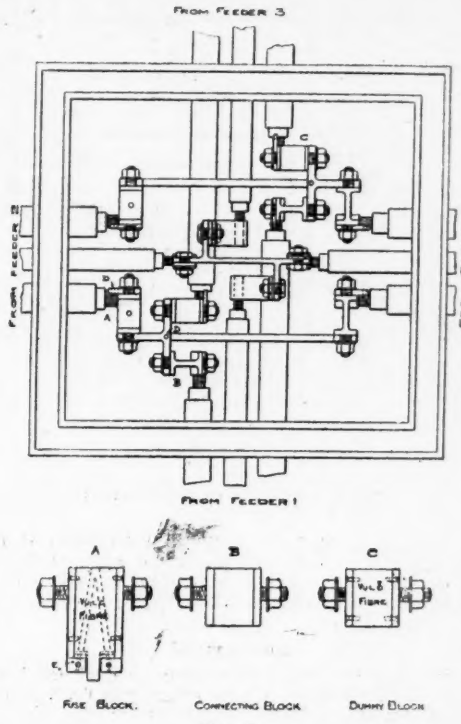


Fig. 7.

would be preferably employed. A copper fuse is inserted in the V-shaped fuse-way from the top, the ends of the wire being soldered into the ears at E. It is to be noted that the fuse-way is open at the top only in order that, if a fuse should blow, the metal and gases may be projected upwards, away from the fittings.

Tapped holes are provided at D D, in which thumb-screws are inserted as a means of connecting ammeter, or switch, when testing, the block being removed. This is obviously useful in many ways.

As all the fittings are rigidly held together, although some of the lines may be electrically isolated, the bars may be supported entirely by the cables, thus greatly improving the insulation.

The joint box shown in fig. 7 is of a type supplied by Callender's Cable and Construction Co., Ltd., slightly modified to take the interchangeable blocks.

Appendix II.

The interrupter and coil for fault localisation is indicated diagrammatically in fig. 8. The interrupter consists of a double carbon and mercury break, the carbon holders being operated directly by the

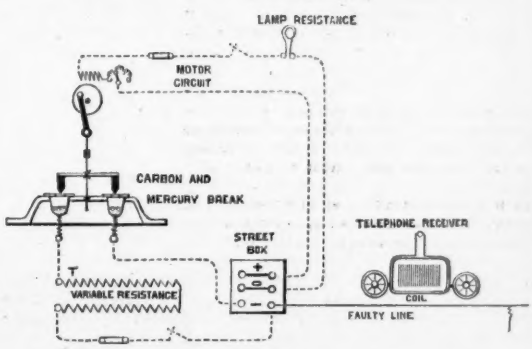


Fig. 8.

motor spindle by means of an eccentric pin and guide. The motor is run at about 150 revolutions per minute, and the current (usually about 10 amperes) through the break regulated by the adjustable resistance. The apparatus is packed in a box in such a way as to make it conveniently portable.

The coil is composed of a mile of No. 18 cotton-covered wire wound on a former, through which are placed charcoal iron plates to form a laminated core. The body of the apparatus is supported by

two longitudinal beams fitting in grooves in the side of the core, and forming the carriage frame. The wheels have solid rubber tires, and are set wide apart to admit of easy turning. The somewhat cumbersome construction is necessitated by the coil requiring to be as near the road surface as possible. The width of the wheel centres also enables the coil to be run over and along a trench.

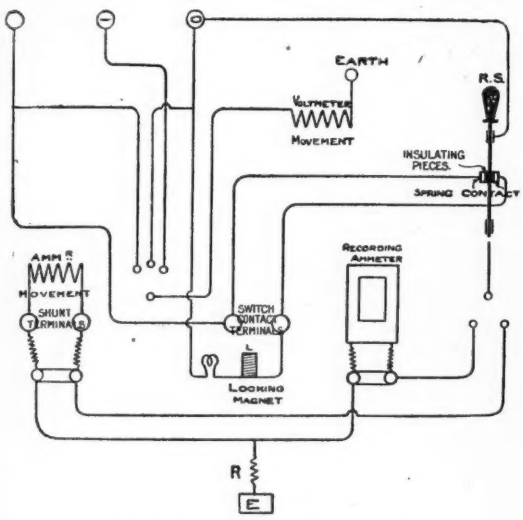


Fig. 9.—Diagram of Connections.

This is a great convenience if the fault-indication should be indefinite, and it is necessary to open ground in several places.

The coil is a modification of one made and used by Callender's Cable and Construction Co., Ltd., for the purpose of fault localisation.

Appendix III.

An arrangement suggested for reading the combined insulation resistance directly is shown diagrammatically in fig. 9. It consists of an ammeter and voltmeter contained in one case. The needles move in two parallel planes and overlap. Between the ampere and volt scales an ohm scale is marked. The scale is plotted for $\frac{v_2}{c}$ — B, the point of intersection of the needles overlying the required reading of F. As v_2 and c cannot co-exist, a special attachment is made to the switch R S, which enables the ampere needle to be locked, while the volt needle deflects.

An insulating wedge is fixed to the blade of the switch which separates spring contacts when the switch is closed, but when it is slightly pulled forward, and before the "earth circuit" is broken, permits the contacts to come together, thus completing the circuit of a locking magnet, which retains the deflection C after the switch is fully opened and the voltmeter has swung to v_2.

The voltmeter and ammeter are entirely independent, and may be used for other tests if required. The voltmeter is provided with a three-way switch, normally held on the neutral stud by a spring.

The instrument (fig. 10) has been supplied by Messrs. Elliott Bros. The reading of F by Russell's test with an ordinary voltmeter and ammeter is very simple, but with the automatic arrangement embodied in the combined instrument a "switchboard attendant" at any station or sub-station can read F instantly (say twice daily) and report to the mains superintendent if the insulation is below the standard. As a voltmeter and ammeter are required in any case, it only means the combination of the two in one case with the addition of an ohm scale, so that it would seem that such an instrument might be usefully employed on a test panel.

A two-way switch is shown in the diagram, but the ammeter portion of the instrument might be coupled across the switch R S (provided with an additional contact), so that the test would be made by opening this switch only.

The range of the ohm scale of the particular instrument illustrated in fig. 10 is small, and consequently is only suitable for use on systems where 40 ohms is well above the limits imposed by the Board of Trade regulations.

Fig. 11 indicates the operation of the ohmmeter under the various conditions shown on the left of the diagram. Two faults of 120 ohms and 40 ohms respectively are shown. The former is coupled in each case to the negative, and may be regarded as representing the normal insulation resistance of the network; the latter is switched on either pole. The two-ohm resistance in series with the ammeter circuit is R. The positions of the resultant lines A B, C D, E F, in the diagram (which is drawn in the manner suggested by Mr. A. M. Taylor, *Journal* xxxii., p. 873) represents the conditions obtaining when the 40-ohm "fault" is switched on each pole in turn, the 2-ohm switch being open. The joint insulation resistance, F, is of course the same in each case, *i.e.*, 30 ohms, and as this value $\frac{v_2}{c}$ — R is cot a, the angle a must be constant, and the lines A B, C D, E F parallel, which is seen to be the case. It may also be noted that these lines are equi-distant. The line G H shows the effect of closing the 2-ohm switch. On the right are shown the positions assumed by the ohmmeter needles,

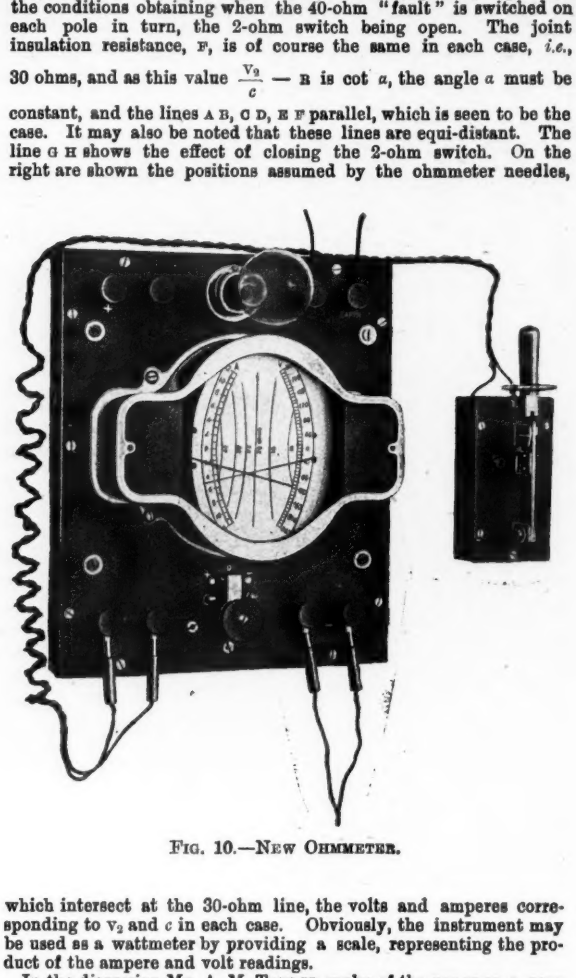


Fig. 10.—New Ohmmeter.

which intersect at the 30-ohm line, the volts and amperes corresponding to v_2 and c in each case. Obviously, the instrument may be used as a wattmeter by providing a scale, representing the product of the ampere and volt readings.

In the discussion Mr. A. M. Taylor spoke of the paper as a very interesting and helpful contribution. Dealing with one part of the subject, Mr. Groves said: "It is also essential for the continuity of

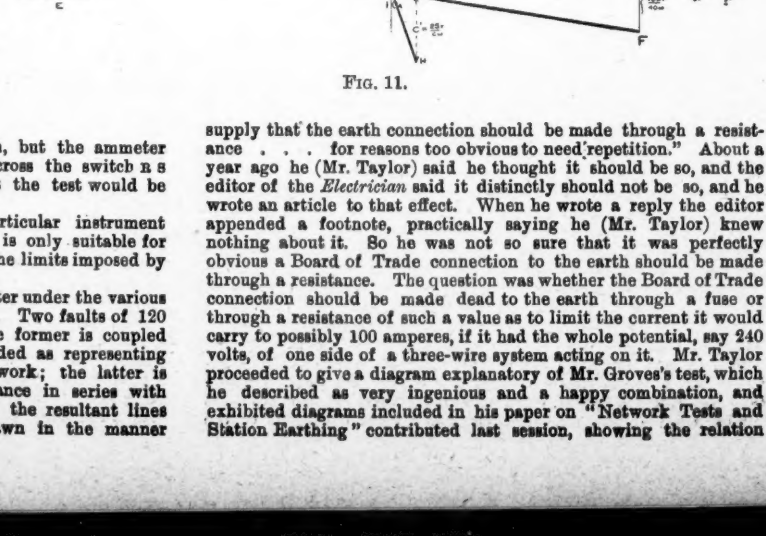


Fig. 11.

supply that the earth connection should be made through a resistance . . . for reasons too obvious to need repetition." About a year ago he (Mr. Taylor) said he thought it should be so, and the editor of the *Electrician* said it distinctly should not be so, and he wrote an article to that effect. When he wrote a reply the editor appended a footnote, practically saying he (Mr. Taylor) knew nothing about it. So he was not so sure that it was perfectly obvious a Board of Trade connection to the earth should be made through a resistance. The question was whether the Board of Trade connection should be made dead to the earth through a fuse or through a resistance of such a value as to limit the current it would carry to possibly 100 amperes, if it had the whole potential, say 240 volts, of one side of a three-wire system acting on it. Mr. Taylor proceeded to give a diagram explanatory of Mr. Groves's test, which he described as very ingenious and a happy combination, and exhibited diagrams included in his paper on "Network Tests and Station Earthing" contributed last session, showing the relation

between the positive, middle and negative currents, and their effect on the potential with regard to earth.

Dr. Sumpner said that, so far as he knew, it was the first time an instrument had been devised embodying the principle of overlapping pointers, and he thought the idea was capable of extension. This instrument, combined with the test which Mr. Russell had pointed out, would be of great service. He wished to make a remark about Mr. Russell's test, which was, he thought, about two years old. Although he did not wish to undervalue what Mr. Russell had pointed out, he would like to say that it depended upon a principle which was considerably over twenty years old. It was this:—Supposing any two points of a system of mains or of wires were at different potentials from any cause whatever (he was speaking of direct currents) so that their potential difference was v_2, you could treat those points exactly as if they were the terminals of a battery whose P.D. was v_2, and supposing you connected them by means of a wire, and measured the current in that wire, you could by the ordinary fall of potential method determine the resistance between those two points. Let them imagine it really was a battery. Everybody knew that if you measured its potential difference v_2, and then measured its new potential v_2^1 when you connected the terminals of the wire; dividing the fall of potential by the current, you got the resistance of the battery. Or if instead of measuring the current you measured the external resistance, you had, of course, a perfectly well-known formula; the resistance F was equal to $\frac{v_2 - v_2^1}{C}$ or $\frac{v_2}{C}$ – external resistance. This was the outcome of the theory; supposing there was no drop of potential when you connected the terminals with the resistance R, then it meant that the internal resistance was nothing, and that was what happened in a system of mains that were maintained at a constant difference of potential. You assumed in your working-out of any formula that the dynamos kept the potential at 220 volts. That meant that for all purposes so far as resistance was concerned—not so far as current or potential was concerned—you could regard the positive main and the neutral main as being connected by a wire having no resistance. He thought the paper was a very valuable one.

Mr. Groves, in reply, said that it seemed to him right to employ in the neutral earth circuit a low resistance which was sufficient to prevent serious damage to the mains or interruption of supply by any accident. If they put a fuse in, it was worse than nothing, because they might think they had an earth connection when they had not. It was a much more satisfactory thing to feel that the leakage was controlled. Of course if they used a resistance they must not be content to think that that resistance prevented a fault doing any serious harm, and that, therefore, a fault did not matter. It seemed to him it was asking rather too much of a mains engineer to require the neutral to be put dead to earth without a fuse or resistance, and of the two the resistance was preferable. The effect of a low resistance was to slightly lower the potential of the sound main with regard to earth from what it would be should the fuse blow, which was a point distinctly in favour of the resistance as opposed to a fuse. When the leakage to earth was small the resistance had obviously little effect in displacing the potential of the neutral.

A vote of thanks was passed to Mr. Groves on the motion of Dr. Sumpner, seconded by Mr. Taylor.

The following are abstracts of communications received after the meeting, which will be read at the meeting of the Section on April 20th, 1904.

Mr. F. Charles Raphael: The subject was an important one, and was too frequently neglected by station engineers. If a man had not made up his mind previously what system he would employ to locate a fault that might develop, he was not in a particularly good position to act promptly and with decision when the breakdown did occur. Moreover, if proper daily tests were made, the breakdown need never take place, as the fault might be discovered and localised before it had become bad enough to blow any fuses. With regard to the first part of Mr. Groves's interesting paper, he would only ask him whether he had actually fixed up a test panel such as he described, and whether it answered in practice. Mr. Groves recommended daily tests by one of the earthed ammeter methods, and in this recommendation he cordially supported him. With the latter part of the paper, on the other hand, he was bound to disagree. Mr. Raphael referred in detail to his fault-localising bridge, maintaining that this apparatus was less elaborate than that required for the induction method of fault localisation. As to practical difficulties, he had carried out scores of localisation tests by the loop method, and had never known one to fail. Turning to the induction methods, Mr. Groves would find full descriptions of these in the book to which he had alluded, and a review of the circumstances in which the methods were and were not reliable. The chief difficulty in carrying out this induction test with satisfactory results was that, in the case of lead-covered or armoured cables, the hum or beat in the telephone did not cease at the fault, but gradually diminished. The reason for this was that the current escaping at the fault did not flow straight back to the station along the sheathing; if it did, there would be no sound in the telephone at all, for the inductive actions of the two currents would neutralise one another. Some flowed straight back, but some continued along the sheathing after the fault was passed, and leaked back to earth through the ground or along any other pipes or mains.

Mr. Geo. Barnard:—As to the final location of faults by the induction method (G), he had had experience of this way of finding faults for the last 15 years, and for single cables of short lengths he had been successful, but for cables a mile or two long he did not consider this method quite satisfactory, owing to the condenser effect due to capacity, &c., it being possible to get a vibration in a telephone with a cable testing many megohms to earth. He much preferred the drop of potential way of locating them. It was easy enough to localise faults with the telephone when they had to deal with cables not having any metallic sheathing or with iron troughs with tile cover, but if they were lead sheathed or armoured, or if the iron troughing had a metal cover, or the cable was drawn into an iron pipe, this method then had its drawbacks, it being very difficult to locate faults with any amount of certainty. He had tried another method with a certain amount of success by having the current broken through a contact breaker at both ends of the faulty cable; one had to be a slow break and the other a quick one, so as to give a different note in the telephone, and when they got the two notes at their loudest pitch, that was the position of the fault, as they did away with the tapering effect of the vibration in the telephone; this was the best way that he knew of when metallic sheathing conductors were used, but for long lines and any system of mains, he preferred the loop test by drop of potential method, as he had got better results from it.

Mr. A. P. Trotter:—Possibly because the generating plant might be considered outside the scope of the paper, no allusion had been made to the advantage of using a separate machine for supplying a faulty network which had been disconnected from the rest by the linking fuses. The use of such a machine presented two advantages. It took the leak off the bus-bars, and it allowed a higher resistance to be put between the middle, or neutral, and earth. This resistance could be adjusted to suit the size of the network, and need be no smaller than would hold down the sound main of the disconnected district to 250 volts from earth. He did not like to criticise the joint box shown in Appendix I., as he had no practical experience with it; but from such experience as he had gained by the investigation of explosions in street boxes, the clearances seemed to be rather small. He would like to see three separate boxes used instead of one—one containing A, B and D, another the neutral connections, and another containing C and the mains connected therewith. Short-circuits in street boxes were too common, and explosions in such boxes occurred with a frequency which was not creditable to English engineering. A small explosion unlikely to have caused any injury to the public often broke or lifted the lid, and let it drop into the box, causing a serious short-circuit. The use of separate boxes avoided this. He hesitated to criticise the fuse block without seeing it, but he did not hesitate to object to the use of vulcanised fibre for any such purpose as this. He understood that a simple tin fuse shunted by a much smaller Mordey fuse broke large currents very quietly in street boxes. It was not uncommon for the blowing of fuses to be reported by the police to the Board of Trade as "explosions."

In reply (communicated) by Mr. W. E. Groves:—The panel illustrated was a simplified form of one he had used for some considerable time. Mr. Raphael had misinterpreted his remarks as to some of the localisation tests described in his book. He did not say they were too elaborate, but that it would be difficult to elaborate on them, *i.e.*, *improve* on them, as tests with sensitive instruments. Considerable experience had led him to prefer the induction method, which had proved almost infallible on mains without armouring or lead covering. His remarks might be taken to imply that the induction methods were not referred to in Mr. Raphael's book. This also he did not intend. Mr. Raphael's book was a most useful one, and should be in the hands of all mains engineers.

Mr. Barnard's remarks were of value as representing the results of long experience. As to the double-break method, he thought, if serious trouble arose in using the simple induction method, a loop test was to be preferred. Mr. Barnard's remarks corroborated what was a generally admitted fact, that the induction test could not be universally employed. Where armoured or lead-covered cables were laid, localisation tests must be adopted.

Mr. Trotter mentioned the advantage of using a separate generator to feed a faulty network. It would certainly be an advantage if the temporary strain put on the sound cable by a fault on the opposite pole could be limited to a small area. The interchangeable blocks in the network boxes were designed to make the system of mains more "flexible" without increasing the number of the street boxes. Mains engineers would regret that Mr. Trotter's wide experience had caused him to form a generally unfavourable opinion of their ability to design satisfactory street boxes; but he had had eight years' experience with some hundreds of the boxes shown in fig. 7, and could not recall a short-circuit in them except an occasional one, common to boxes of all types, caused by carelessness of workmen when manipulating the connections.

As regarded the use of fibre in the construction of the fuse block, it was not proposed to use this material where the fuses would be normally heated. It was mechanically superior to porcelain as a support for the bars, and was unaffected by the sudden blowing of a fuse. He had been unable to find any better material than porcelain for heavier fusing blocks; in fact, this would meet all requirements if it would stand strain or knocking about. The fibre fuse block had been short-circuited across 440 volts without suffering any harm.

Belfast—Bangor Railway.—It is rumoured that the directors of the Belfast—Bangor branch of the County Down Railway are contemplating the introduction of electric traction. The line has a length of about 12 miles. The secretary of the company, whilst stating that the directors do not contemplate "immediate electrification," admits that they have been watching the progress of electrification of lines in England with interest, particularly the Liverpool and Southport line.

SMALL GAS ENGINES v. ELECTRIC MOTORS.*

By H. E. M. KENSIT, A.M.I.E.E.

In view of the widespread and increasing use of small gas engines and of the claims of great economy made for them, it is interesting to observe their actual performance under ordinary working conditions, which, in the majority of such cases, means either partial or intermittent load. It is especially in these cases of partial or intermittent load that large economies can be secured by substituting an electric motor, since the motor scores both on account of its much greater efficiency at small loads, and of the ease with which it can be started and stopped when not required. The greatest cause of expense with the gas engine is that it must be kept running continuously on intermittent loads, on account of the time and trouble required to re-start it.

		A	B	C	D	E	F	G	H	I	K	L	M	N	O
		Stated conditions.									Cost in pence per B.H.P-hour.			Annual saving by electric driving.	
Trade.	Rated B.H.P.	Average load.	Hours run per week.	B.H.P.-hours per quarter.	Actual B.H.P.-hours per quarter.	Load factor per cent.	Cost of gas per quarter.	Running costs per quarter.	Total costs per quarter.	Per cent. cost of gas to total costs.	Running cost with gas.	Total cost with gas.	Total cost at 1½d. per unit.	in £.	in %.
							£ s.	£ s. d.	£ s. d.					£ s.	
1. Baker	5	3·75	15	733	522	54	2 6	4 16 6	6 6 6	36	2·2	2 91	1 74	9 4	36·3
2. Clothing factory...	33	16·5	50	10,725	9,469	44	36 10	52 12 10	57 6 10	64	1·33	1·45	1·44	1 10	0·65
3. Engineers ...	11	11·55	10	5,082	2,300	27	11 0	16 10 0	18 15 0	59	1·72	1·96	1·45	15 8	20 5
		5·5	50												
4. Builders	7	3·5	54	2,457	935	19	6 0	8 5 0	9 16 0	61	2·12	2·52	1·60	12 10	32
5. Wood turner ...	8	4	44	2,288	577	12·6	4 10	6 11 6	8 8 6	53	2·73	3 5	1·89	15 10	46
6. Joiner	11	5·5	42	3,000	447	7·4	4 5	5 19 0	7 17 5	54	3·2	4·22	2·15	15 10	49
7. Builder	14	7	48	4,368	610	7	5 10	9 1 0	12 0 10	46	3·56	4·72	2 25	25 5	52
8. Mineral water ...	½	½	60	390	390	100	6 15	10 1 6	12 6 6	55	2·45	3·0	1 70	21 6	43
	4	3	38	1,989	596	30									

All the above engines are operated with illuminating gas at 2s. 9d. per 1,000 cb. ft. The consumption assumed at average load (column A) per B.H.P.-hour is for (1) 32 cb. ft. at three-quarter load, (2) 28 at half load, (3) 22 at full, 30 at half, (4) and (5) 32 at half, (6) and (7) 30 at half load. The consumption assumed at no load is from 30 to 50 cb. ft. per hour, according to size.

Columns A and B are particulars given by user, and C is the product of A and B for comparison with D.

Column D represents the B.H.P.-hours of *useful work* calculated from the gas consumption.

Column E.—Load factor, given for the purpose of comparison, is taken as $\frac{\text{B.H.P-hours of useful work}}{\text{Hours run} \times \text{full load}}$.

Columns F and G are particulars given by the users. Details were given for F, which represents "works costs."

Column H is obtained by adding to column G 5 per cent. interest and 5 per cent. depreciation per annum on cost of engine.

Column M.—The estimated cost for electric driving allows for efficiency of motor, 5 per cent. interest, 3 per cent. depreciation, and 2 per cent. repairs, with 7 per cent. added to actual B.H.P.-hours for contingencies, except in cases 1 and 2, in which the load is continuous.

Columns N and O.—These, and also column M, are added for comparison only. They can be easily worked out for any given conditions to show what the saving should be.

The accompanying table gives particulars recently obtained of the cost of operating a number of small gas engines used in various trades. The essential particulars were all obtained in detail from the users, and in most cases represent the average of several quarters' working. It is not claimed that the calculated costs per B.H.P.-hour are exact, since they depend upon the assumptions given below the table; but as these assumptions are, if anything, favourable to the gas engines, it is believed that they do give a close approximation to the actual results under every-day working conditions.

With reference to Column D, it may be objected that this is from calculations, and not from actual tests; but given the size of engine, the hours run, and the amount of gas consumed, then the cost per B.H.P.-hour of useful work is a fairly definite quantity.

Thus, if we take the worst case, No. 7, in which the running costs with gas come out to 3·56d. per B.H.P.-hour of useful work, and endeavour to make this look more favourable for the engine. The example as given is worked out for half load at 30 cb. ft. per B.H.P.-hour. Now, if we assume three-quarter load at 25 cb. ft. for shorter hours, the answer comes out to 3·31d., and if we assume quarter load at 40 cb. ft. for longer hours, the answer is 3·76d.; and the average of the last two figures is 3·53d., or practically the same as the first figure.

As to the cost of repairs to motors, it is interesting to note from the paper read by Mr. D. Selby Bigge before the Iron and Steel Institute in 1902, that at Messrs. Richardsons, Westgarth & Co.'s works, which are equipped throughout with three-phase motors, "the cost of renewals and repairs over a period of five years has been extremely small, certainly not 1 per cent. of the value of the installation."

It is also of interest to note the proportion between cost of gas, running and total costs. The difference is, of course, much greater than in the case of an electric motor, on account of the greater first cost, depreciation and repairs, and the cost of oil, water, attendance, &c., to the gas engine.

In estimating the cost of electric driving, it is, of course, assumed that full advantage would be taken of using separate motors for the individual machines where desirable.

The writer would wish it to be distinctly understood that the object is not to show that the saving would be exactly that estimated in any particular case, but that for such intermittent loads a large margin in favour of electric motors does exist.

* See article in our issue of February 26th.

THE REPORT OF THE MOSELY EDUCATIONAL COMMISSION.

It can be hardly necessary for us to preface our account of the Mosely Education Report by any description of the aims or constitution of the Commission, for we may fairly assume that these matters are well known to our readers, who belong to that portion of the British community which realises that education is something more than a pretext for party and sectarian squabbles. The report itself as drawn up somewhat resembles that previously issued by Mr. Mosely as the result of his Industrial Commission: that is to say, it comprises a list of the Commissioners with their qualifications, a general preface by Mr. Mosely recording his own impressions, the individual reports of the 26 investigators (which extend to some 400 pages of close type), and a summary of the contents of those reports drawn up by Prof. Armstrong. We may say at once that this last item is disappointing. We turned to these pages hoping to find that Dr. Armstrong had given us a concentrated essence of the conclusions arrived at by his fellow commissioners; but, as a matter of fact, he has prepared scarcely more than a publisher would call a "table of contents." One or two of the separate reports suffer from extreme brevity, but several err seriously in the other direction; and some of the more verbose writers deal largely in generalities, as well as committing what is elsewhere acknowledged to be the British educational sin of overlapping. The majority of the reports, however, are replete with statements of fact and opinion which merit most careful attention; while they have the additional virtue of viewing and criticising the

same phenomena from the totally different standpoints of the general teacher, the professor of science, and the education "authority."

In the present place we are mainly concerned with the lessons we may learn from the United States about the proper method of arranging the specialised training of the student in electrical, mechanical, and chemical engineering; and we, therefore, naturally tend to turn first and to devote the bulk of our attention to those reports which are signed by our special "representatives," viz., Messrs. Ayrton and Maclean (electricians), Armstrong (chemist), Ripper (engineer), Bradford and Gaskell (doctors). But since general education must precede special training, and since special training is simply one means to the end of making men's lives valuable to their fellows, we are bound to study the opinions of the non-technical Commissioners first.

Before doing this, however, we feel bound to protest against the results, while thoroughly appreciating the motives, of a resolution passed by the Commission on its assemblage in New York. It was agreed that "In the reports . . . . no reference should be made to politics in any shape or form, and also that the thorny question of religious controversy in connection with education should be absolutely ignored, even to the extent of not putting on record the views held on the subject in America." Now, if our reading has not misled us, there is a considerably larger number of religious sects in the States even than in this unhappy land, and we have no reason to imagine their exponents less exclusive. Yet we find American parents treating doctrinal differences as on a level with social and monetary ones, sending their children to sit cheek by jowl with the infidel and the sectary, the pauper and the budding millionaire, in the primary and later schools. How this comes to pass the Commissioners have not allowed themselves to explain; and yet, perhaps, it is of all things the most important question for us here. If it arises merely from a love of and belief in education, as the omissions in the Mosely report would almost persuade us to think, we can, indeed, ask no clearer proof of the broader intelligence of the adult American, who apparently will not permit his whole country to be brought into a state of uproar by a minority of zealots for the sake of matters that are non-essential.

We may now quote the joint report of the Mosely Commissioners, as follows:—

"The members are deeply impressed by the evidence they have gathered in the United States of the absolute belief in the value of education both to the community at large and to agriculture, commerce, manufactures and the service of the State. Although in the past the belief in education has been the effect rather than the cause of American prosperity, during the last quarter of a century education has had a powerful and far-reaching influence, and it cannot be doubted that in the future it will become more and more the cause of industrial and commercial progress and of national well-being. They are satisfied that in years to come, in competing with American commerce, we shall be called upon to face trained men, gifted with both enterprise and knowledge. They desire to impress on the British public the absolute need of immediate preparation on our part to meet such competition. They have also been impressed with the spirit which animates both teachers and pupils, and by the manner in which the two classes co-operate in the schools and colleges. Willingness, if not an overwhelming desire, to learn seems to characterise the scholars; and teachers seem to be possessed of but one wish—that of helping their pupils in every possible way. The absence of class prejudice and of any 'religious difficulty' serves most materially to facilitate the work of the schools. The closest connection is being established between theory and practice, the practical bent of the men of letters and science, and the breadth of their outlook, being very remarkable. The services of experts in various branches of knowledge are therefore held in high esteem, and are in constant demand. The important part which manual training is beginning to assume in the schools struck them very forcibly. Such work appears to be in many ways of high value as an educational discipline, especially in developing handiness and alertness, and in familiarising the scholars with constructive processes. They have been much impressed with the liberality displayed, not only by the public, but also by private donors, on behalf of education, as evidenced by the wealth of provision in the form of buildings and equipment which is everywhere made. On the other hand, they observe that the remuneration of teachers is by no means always placed on a satisfactory basis, and they have been led to view somewhat with alarm the growing preponderance of women teachers. Lastly, they would draw attention to the extent to which the work of education is organised, and its various grades co-ordinated, whereby harmonious working is secured, and overlapping avoided. The need of effecting such organisation in this country, which was before apparent, now seems to them imperative, in view of the experience they have gained in the United States."

From this report, Prof. Ayrton dissents so far as the preponderance of women teachers is regretted, while Mr. Blair (Agriculture and Technical Instruction Department, Ireland) regards the subject as an open question. The reason for this preponderance of women seems to be partly one of money, for it is said that the salaries offered to teachers are sufficient to attract the best class of women, but only third-rate men; partly it may depend on politics, for the teacher's tenure of office often seems to be at the mercy of the local party wire-pullers. The objections to women are that they tend to produce an effeminate youth, one who "is not brought up to punch another boy's head or to stand having his own punched in a healthy and proper manner," as Prof. Armstrong characteristically puts it. Moreover, being admittedly deficient in originality as a sex, women teachers do not stimulate that bent of mind which in after years should make for research. Having mentioned the word "sex," we may note here that several of the commissioners deal with "co-education," *i.e.*, the simultaneous teaching of boys and girls, which is very common in the Western States. The opinions expressed as to the merits of the system differ; perhaps the general verdict is that it has moral advantages and intellectual defects, the former being a trifle the greater.

The keen appreciation of the value of education possessed by all adults, and the firm intention displayed by all juveniles to get it, has impressed the commissioners more than anything else; but as the Rev. Dr. Gray (warden of Bradfield College) remarks, the stern and unflinching motto: "If thou wilt not work, neither shalt thou eat," may be imagined written on the portals of all colleges. We read stories of boys earning the fees for their education by working as night watchmen, tram conductors, farm labourers, as though this report were a collection of Scottish biographies; and with irresistible logic comes Mr. Ripper's statement that a student who acts like this will want his money's worth out of his college, and will make himself very much heard if he does not receive it. The American boy goes to school, to college, to the university in order to learn; not to make socially useful friendships or to get a "blue." Sport is not the solitary object of real emulation as with us; it is not neglected, but takes a lower rank, although President Eliot, of Harvard, whom Dr. Armstrong quotes, complains of the loss of time caused to students by accidents in the football field. Throughout the lower establishments physical exercise is encouraged, chiefly, perhaps, in the shape of gymnastics; but our study of the reports leads us to the conclusion that, as in our large public schools, those unnamed boys' games which best inculcate self-reliance and personal action, are prone to be sacrificed for the production of a formidable football or cricket team, which is a better advertising agent, but in which only the few can play.

The Commissioners, as a whole, do not find much to admire or to be worth copying in the non-technical schools of America, except in matters of business, and the absence of the cut-and-dried examinations of the United Kingdom. Presidents and professors are given clerks to relieve them of office work, money is lavished on buildings, but the methods of teaching are no better, some investigators think them worse, than those of our country. On the other hand, in many institutions the pupils are allowed to cross-examine and encouraged to discuss matters with the teachers in a way that the British schoolman would consider subversive of discipline—the higher proportion of teachers to scholars, however, perhaps makes that possible in the States which would be dangerous here. One task the United States elementary school performs to admiration: it takes the children of parents belonging to all the nations of the earth who emigrate thither, and in a few years converts them into enthusiastic and patriotic Americans. In the higher schools the

actual teachers are held to be the best judges of their pupils' progress, and therefore they are given more liberty to modify the system of instruction to individual requirements. If periodical inspection on the part of College and University professors shows that the schools are doing honest work, the teachers are allowed to recommend their best scholars to the colleges without having to cram them for an entrance examination.

The American youth who intends to enter upon a professional career generally remains so long at the non-technical schools and colleges through which he passes that he enters the special training establishment at a greater age (18 and upwards) than is the case with us. This naturally rejoices the professor of science, who finds that it is possible to do much superior work with them than with younger boys, owing to their greater sense of responsibility and more extensive mathematical training. But this higher age of entry means a higher age of graduation, and in the States a technician may be nearly 30 years of age before he is fully qualified. Fortified to some extent with statistics given him by President Eliot, Prof. Armstrong brings a severe indictment against American methods in this particular. His points are that so long a period of study implies a most serious limitation on the time during which the individual exercises independence, it casts an improper burden on parents, and it postpones the age of marriage unduly. Mr. Eliot's figures show that of 881 students who graduated in the six years 1872—77 from Harvard, 634 married, the number of their children alive in 1902 being 1,262. If half those children are males, these 881 students have failed to reproduce their numbers by 28 per cent. We have no means of judging to what extent such figures may be typical of the educated classes of the States, and we have turned with feelings of expectation to the two reports signed by Dr. Bradford (Professor of Medicine in University College), and by Dr. Gaskell (Lecturer in Physiology at Cambridge), respectively to see whether they have noticed the matter. Dr. Bradford is disappointingly narrow in his report, thinking of little but his "final" examinations; and Dr. Gaskell limits himself to the remark that the length of time (say eight years) consumed in obtaining first the college degree, and then the M.D., "is recognised as a drawback."

We should like further opinions or evidence as to this backwardation of the average age at marriage; because, if the lengthy American system of educating men of science is responsible for it, that system is not fit for us (or them); and economy of time must be effected in the non-technical schools, by teaching fewer "subjects" and by concentrating attention on a cultivation of the intelligence which renders the pupils capable of teaching themselves.

(To be continued.)

THE RIGHT TO OPPOSE A TRAMWAY BILL.

[FROM A LEGAL CONTRIBUTOR.]

In considering the promotion of a Bill for the purpose of obtaining Parliamentary sanction for a tramway, those who are responsible for an undertaking of this kind find it necessary to consider the nature of the opposition which their proposals are likely to excite. If they are a local authority, the scheme may not meet with the approval of the ratepayers; if they are a private company, the local authority, or frontagers along the route, or, in fact, any persons whose interests run any risk of being interfered with may desire to raise objection to the scheme. Seeing that opposition has to be reckoned with, it is all important for promoters to be in a position to deal with their opponents at the earliest possible moment. Let us therefore inquire into the rules which have been laid down, whether by statute or otherwise for the purpose of enabling objectors to be heard in opposition to a tramway Bill.

We shall confine ourselves in the present article to the rules relating to the opposition to tramway schemes which are sought to be authorised by a private Bill in Parliament.

Broadly speaking, it is open to those who have a sufficient interest to oppose in Parliament any particular scheme, and to urge its rejection on the ground that the proposed line or lines would be so detrimental either to general traffic or to the interest affected as to outweigh any public advantage which would be gained by the construction of the tramway. The right to oppose involves the right to appear by counsel and call witnesses before the Parliamentary Committee who have the duty of considering the proposed measure. The question whether a particular opponent shall be allowed to appear is discussed before what is known as the Court of Referees. That Court has the duty of deciding (with regard to Bills which are before the House of Commons) whether any particular petitioner against a Bill has a right to be heard. To use a phrase in common use, the Court decides whether he has any *locus standi*. Important cases heard by the Court of Referees are reported in what are known as the *locus standi* reports. The recent issue of a new volume of these reports has suggested to us that a short statement of the law and practice, illustrated by reference to the most recent cases, might be of very general interest.

The grounds upon which a *locus standi* may be granted are (1) competition, *e.g.*, as where an omnibus company claim that the tramway will interfere with them; (2) interference with property, *e.g.*, as where the opponent claims that the tramway will interfere with him in the enjoyment of his property. For instance, a gas company might allege that the laying of the tramway would probably interfere with gas pipes and mains.

Dealing first with the question of competition, the Standing Orders of the House of Commons give the Referees complete discretion as to the admission of petitioners to be heard on this ground. It was formerly the practice of the Court of Referees to decline to allow a railway company to oppose on this ground, but the adoption of electricity as a motive power, has effected a change in this respect. Thus, in 1893, a railway was allowed a *locus standi* against the clauses and schedule of a Bill which authorised and regulated the use of electricity on certain tramways, inasmuch as they might directly or indirectly affect the railway; but it was given no general *locus*, on the ground of competition, since the Bill, which also included certain powers of purchase and amalgamation, was held at most to improve existing competition. In another case in the same year, the same point was decided in much the same way, though there was an additional question as to the safety of certain bridges over the railway.

It is with reference to interference, however, that we wish to draw attention to some of the recent cases. The Board of Trade regulations are usually wide enough to give sufficient protection, and, if this is the case, it appears that the Court of Referees will not permit an opposition.

In the Cavehill and Whitewill Tramways Bill (2 S. & A., 98), the Bill empowered the promoters to work their tramways by electrical power. Clause 5 proposed to alter the model clause, which provides that the Board of Trade shall make regulations for securing to the public all reasonable precautions against danger, by adding a proviso that the promoters shall not be required at their cost to fix guard wires over their lines for protecting any wires erected after the completion of their tramways. By Clause 6 special provisions were inserted as to the use of electric power, and it provided that this should be used only in accordance with the Board of Trade regulations. The petitioners alleged that their telephonic plant would be interfered with during construction, and claimed to be heard to obtain protection similar to that afforded by Sec. 30 of the Tramways Act. They also claimed to be heard in respect of their overhead wires against the proposed alteration of the model clause. The promoters contended that the protection afforded by Sec. 30 of the Tramways Act was inapplicable, and that the model clause was inserted in the Bill for the protection of the public, and not for the protection of the petitioners, who were amply protected by Clause 6. It was decided that the petitioners were not entitled to be heard.

In this case the *locus standi* of the petitioners was objected to on the following grounds:—(1) No lands or property of the petitioners will be compulsorily taken or interfered with under the Bill; (2) the only provisions objected to in the petition are those with respect to electrical power, and the erection and maintenance of apparatus for that purpose over streets and other places, and the alteration of the tramways for that purpose, and for additional crossings, but the petitioners have no such rights or interests (either statutory or under the common law) in any such street or place, or over or above the same as entitles them to be heard; (3) the Bill contains or incorporates all the provisions for the protection of all existing telephonic wires and apparatus, to the benefit of which the petitioners are entitled, and under those provisions the Board of Trade are empowered to make from time to time all necessary regulations for their protection, and the petitioners are not entitled to be heard to ask for any further protection in respect thereof, or as regards any wires which may be erected under the Bill after the completion of the tramways.

In the London County Council (Tramways and Improvements Bill), which was heard on May 2nd, 1902, the Westminster Corporation sought a *locus standi* to be heard in opposition. The Bill, *inter alia*, authorised the promoters to construct a tramway along the Victoria Embankment, of which they were the road authority. The petitioners were the road authority for the City of Westminster, excepting the Embankment, and alleged that they were injuriously affected by the proposed tramway, and claimed to be heard on the ground that, as the promoters might compel them after the tramway was constructed to take over the control of the road, their liability would be increased. They also alleged that the proposed tramway would divert traffic and cause obstruction, and they further claimed to be heard as a municipal authority under Standing Order 134.

They further alleged that the amenity of the Embankment would be destroyed, and that this would cause special injury to the inhabitants of Westminster. The promoters contended that the petitioners were not a municipal or other authority having the local management of the metropolis within Standing Order 134, and that they were not, therefore, entitled to be heard. The Committee decided, nevertheless, that they were entitled to be heard under Standing Order 134.

The *locus standi* of petitioners (1) was objected to on the following grounds:—(1) The Victoria Embankment roadway, upon which a tramway is intended to be made, is vested in and under the control and management of the promoters, and the petitioners are not, and do not allege that they are, either the local or road authority with respect to this tramway, or that they have any

jurisdiction with respect thereto; (2) the petition does not disclose, nor have the petitioners any such interest in the subject matter of the Bill, nor will their property or rights be interfered with by the powers thereof in such manner as to entitle them to be heard.

In the same case the Committee were asked to adjudicate upon the *locus standi* of certain of the owners, lessees, and occupiers being frontagers along the route. They claimed to be heard under Standing Orders 135. The promoters contended that the petition did not sufficiently allege that they were injuriously affected in the terms required by Standing Orders 135, and that the premises in respect of which some of the petitioners sought to be heard were not "in any street through which it was proposed to construct a tramway." It was decided that the petitioners were entitled to be heard under Standing Order 135 on the grounds specified therein, but that it was for the Committee to decide whether the petitioners were "in the street" within the Standing Order. The importance of this decision lies in the fact that by conferring a discretion upon the Referees to decide what is interference, Parliament allows for the changes which may take place in the character of the disturbance. Thus, the nuisance occasioned by a horse tramway might not extend so far as that caused by an electric tramway.

Another case shows that the law relating to electrolytic action upon gas and water pipes is not yet definitely settled by Standing Orders.

In the Scarborough Tramways Bill (March 7th, 1902) the Scarborough Gas Co. sought leave to oppose a Bill authorised for the construction of electric tramways. The petitioners alleged that their mains would be interfered with, and that they were insufficiently protected by Sec. 30 of the Tramways Act, and that they would also be liable to damage by electrolytic action, in respect of which they were insufficiently protected by the general law. It was decided, following the decision in the London United Tramways Bill, 1901, that the petitioners were only entitled to be heard with regard to electrolytic action.

SOME DETAILS OF THE WESTINGHOUSE SINGLE-PHASE RAILWAY SYSTEM.

By W. PERREN MAYCOCK.

In the pages of a contemporary, Mr. W. M. Mordey is dealing, in a popular manner, with the subject of electric traction for railways; and it is gratifying to see that so well known an engineer falls into line with many others, who have given attention to the subject, regarding the methods that are likely to be employed in the coming general electrification of our steam lines. In particular, he with Mr. George Westinghouse and others who have written on the subject, are virtually in agreement as to the utter impossibility of any extensive adoption of the third-rail (to say nothing of the fourth rail) system on suburban networks or long main lines. On the other hand, the three-phase overhead system suffers from various disadvantages—both electrical and mechanical; but with a single-phase system at hand, the three-phase method ceases to have any *raison d'être*, so that it is practically unnecessary to give any further consideration to it.

It is already pretty well known that the Westinghouse Co. have developed a single-phase system of electric traction, and I am in a position to give somewhat more detailed information than has hitherto appeared concerning the same.

The superiority of single-phase alternating over direct current working for use on suburban and main lines of railway is not hard to see. As commutation is unnecessary with alternating current, a higher line voltage than that available with direct current rotary converters becomes possible, with the result that the third rail may be replaced by the overhead wire. This sweeps away at once the main difficulty which has stood in the way of the electrification of the steam railways; for though it is true that two or three small and more or less self-contained systems have been—and are being—converted to electrical working, it is safe to say that third-rail construction would be almost if not quite impossible on intricate suburban networks and long main lines. Obviously the placing of a charged conductor between or at the side of the running rails would have a demoralising effect on the majority of the men working on the line, and would enormously increase the difficulties and cost of keeping such a line in order. But in addition to these considerations there are grave electrical disabilities; such as the heavy currents, large drop of volts, enormous waste of power, and electrolytic action which low-pressure direct-current working involves.

It is essential that a motor for railway work shall be capable of operating at variable speeds, and that such speed variation should be under complete control. Hitherto the direct-current motor has been the only one to fulfil these requirements, but even this much lauded type of motor possesses a drawback in that there are only two speeds at which it will work with full efficiency; these being when the two motors on the car are connected either in series or in parallel without resistance. There are, of course, numerous intermediate speeds with more or less resistance in circuit, but unless the resistance wires or strips be made unusually heavy, thereby greatly adding to the expense and weight of the equipment, these speeds can only be used for short intervals, and in any case there is a large waste of energy in the resistances. As regards the latter, it has been calculated that something like one-quarter of the total energy used by a train or car (on the direct-current system) over any given distance is wasted in the resistances.

The use of single-phase alternating current enables a speed variation to be obtained without the use of any resistances whatever, the voltage being varied from zero to the maximum by means of a regulable transformer having its secondary wound on a rotatable core mounted inside a shell carrying the primary winding. A simple construction of this kind would consist of a two-pole stator with a rotor in the form of a shuttle carrying the secondary, the ends of the latter being connected to slip-rings. Now, with the axis of the secondary at right angles with the axis of the primary stator field, there would obviously be no induction, and consequently no volts on the secondary. When, on the other hand, these axes were coincident, the volts induced would be a maximum. It is evident, therefore, that a range of movement of 90° would secure all the gradations of voltage from zero to the maximum. The above shows that a regulable or variable voltage transformer need not be at all a complicated appliance; but the construction of the particular form employed in the Westinghouse system is not exactly after this simple pattern, though it is by no means complicated. The obvious advantage of the arrangement is that this economical variation of voltage secures a corresponding economical variation of speed, and that continuous running is possible at all speeds up to the maximum. Further, the maximum voltage at the motor may be made as low as needful, thus rendering the risk of short-circuits, burn-outs or fire almost negligible.

This ease of voltage transformation, peculiar to the use of alternating current, enables economies to be effected at all points. For instance, the sub-stations may be fed at anything up to 10,000 volts from the generating centre or centres; the line voltage may be 1,000, 1,500, or 2,000; and the motor voltage 100 or so. A static transformer carried on the car is interposed between the line and the variable-voltage transformer, and the two effectually protect the motor, &c., from lightning. The substitution of static for the D.C. rotating machinery in the sub-stations is an obvious saving of first and running costs, and to this may be added the saving on attendance.

The Westinghouse single-phase railway system is the outcome of several years' experiment, and it is not generally known that the Westinghouse Co. are equipping the Washington, Baltimore and Annapolis Railway on this method, the line being some 30 miles long, with a branch of 15 miles, making 45 miles in all. This line will probably be completed some time this year, providing the recent disastrous fire at Baltimore does not set matters back. Their experimental line is at East Pittsburg, and here is to be seen an exhibition car, which has been inspected and tested by many prominent engineers, with most satisfactory results.

The heart of the system, of course, lies in the motor, and the credit of evolving a workable single-phase motor for railway service is undoubtedly due to Mr. B. G. Lamme, of the Westinghouse Co. The standard sizes are to be of 50, 75, 100, and 150 H.P., with a frequency of 25 cycles. The field consists of a laminated cylindrical core of soft steel punchings, bolted and held together in a frame of cast steel. Lugs on this frame provide for the suspension of the motor and the support of the gear case; and the armature bearings are carried on the end covers or "bells" which are bolted to each end of the frame. Inwardly projecting field-poles of rectangular section form part of the fixed core, the copper strip edge-on coils being separately formed and insulated before being put on.

The open slot armature is of the drum type and the machine-formed coils are also of copper strip. They are held in place by hard fibre wedges fitting in grooves in the core teeth, and there are consequently no binding wires.

The complete equipment for a car is as follows:—Two master controllers; four motors, complete with gearing; main auto-transformer; transformer for lamp circuits; balancing transformer; induction regulator or variable-voltage transformer; motor for air compressor; storage battery of 14 cells; Westinghouse air-brake equipment, together with a circuit breaker, various switches, two resistance grids, junction boxes, and connecting sockets and plugs.

With the exception of the controllers, all this equipment is placed underneath the car body.

Two motors are mounted on each truck, the fields and armatures of each pair being connected in series, and the two pairs joined-up in parallel. Equal voltage at the four armatures under all conditions of service is ensured by connecting the balancing or equalizing transformer across the outers of the two armature circuits, with its middle point joined up to the middle point of connection of the two armatures forming each pair.

The trolley voltage is reduced to about 300 volts by means of the auto-transformer, and the latter feeds into the regulating transformer, which brings the pressure down to 100 volts or so at each motor. This regulating transformer is operated electro-pneumatically, air for this purpose being supplied by the motor-driven compressor, which also feeds the air brake cylinders. The valves operating the latter are controlled by electro-magnetic switches actuated by current from the battery.

CHAIN GRATE STOKERS.

Mr. A. Bement has presented a paper to the Western Society of Engineers, on the performance of boilers with chain grate stokers and the means for improving them. In a sense, the chain grate stoker, or Juckes's furnace, is one of the best of all mechanical stokers. It is practically perfect as a self-cleaning grate, and it is a coking stoker of the simplest form. In other respects it is faulty, because its fire burns very thin at the back and admits enormous volumes of useless excessive air, only to cool the boiler

and flues and reduce the efficiency of the whole plant. Cases are on record with this class of grate where as little as 2 per cent of CO_2 has been found in the resultant gases.

Much of Mr. Bement's paper is occupied with a discussion of the Heine and the Babcock types of water-tube boilers.

It was found that in the case of the Heine boiler a very large improvement in efficiency was brought about by the use of two additional baffles placed so as to give the gases a longer flow in passing the tube surface. The furnace, also, was an improvement upon the ordinary furnace, being of such dimensions and length of refractory chamber as to enable the fuel to be perfectly burned before submitting the gases to the chilling effect of the tubes.

The author of the paper rightly emphasises the importance of high furnace temperature, and ridicules the idea that any good can come from excessive air, pointing out the essential difference between heat and temperature. As he says, a certain quantity of heat may be present in a small amount of gas at a temperature that will melt iron, or the same heat may be present in a large amount of gas at a temperature that will freeze water.

The author realises the want of mixture which occurs with the ordinary furnace, and advocates what he calls the tile-roof furnace, by which perfect combustion can be effected with, he claims, as much as 17 per cent. of CO_2, and even 19·3 per cent. for short intervals. He makes no reference to the Coxe device for moderating the flow of air through the grate when burned bare, but appears to rely upon an initially thick bed of fuel through which very little air can flow, and on the closing plates named lower down, which effect the same purpose more or less perfectly. The combined gas from the one end, and the excess of air from the other end of the grate, together form a fairly proportioned mixture. Probably the chief points of the paper are the advantages to be gained from the use of tile-baffles so arranged as to divide the bank of tubes somewhat in the ratio of the gas temperature, so that the velocity of gas flow is maintained nearly uniform, and the advocacy of the so-called Dutch oven type of furnace, whereby alone bituminous coal can be burned with any degree of smokeless and economical perfection. It is strange that in America scientific methods of combustion are more considered than they are here, where the most smoky boiler is of American origin and is installed by steam users, who ought to know better, just as it was first imported fitted only for anthracite coal.

In the Western States, where there is no anthracite, the furnace of the Heine boiler is a distinct advance over the common type, and the furnaces advocated by Mr. Bement are again improvements. The Western engineers seem to have studied combustion and to have arrived at sound conclusions. In the paper before us there is a remarkable store of knowledge displayed by the speakers in the discussion of the subject of bituminous fuel combustion. Why is it that the American engineer of the Western States does things so differently from his Eastern brother, and enters into questions of combustion in a manner that our own engineers would do well to follow?

In the form of furnace advocated by Mr. Bement, about half the length of the chain grate lies to the front of the front header, and the ordinary heavy brick arch lies almost wholly outside the boiler. Beyond the heavy arch the lowest row of tubes is cased in tiles to a point no less than 16 ft. from the coal gate, the last 3 ft., however, not being fully cased, the lower half of the tubes being exposed. To prevent excess of air, it is advised to close the openings at the side of the stoker frames, between the top and bottom chain and between the bottom chain and ashpit floor, so as to stop inflow of air. This is done towards the back of the grate. The dampers to effect this must span two joints of the chain. Some such means must usually be adopted, for it will usually be difficult to feed coal so thickly as to secure a combustion so as to proportion the air supply at the back of the grate to suit the gas output at the front. With the choking dampers, however, the fuel bed can be moderate, and the air can be shut out from the back to any extent desired.

We see no reason to question Mr. Bement's contention that the chain grate, properly arranged, may be made to give good results. But to enable it to do so not only must the air supply be properly regulated, but the form and material of the furnace must also be good. It is at least satisfactory to find that there are engineers who realise fully the evil of turning bituminous gases amongst cold tubes directly they rise from the fire, unmixed with air, and hopelessly out of ignition range.

DISPERSION AND WAVE LENGTH OF N-RAYS.

In a paper recently read before the French Academy of Sciences, Prof. Blondlot records his experiments on the dispersion of N-rays, in connection with which the wave lengths of these rays were measured. The method used is similar to that employed in connection with light rays. The radiations produced by a Nernst lamp, after traversing a window closed with aluminium foil, passed through a board of pine wood, 2 cm. thick, another aluminium foil, and two sheets of black paper, so that any other radiation might be expected to be eliminated. By means of a slit made in moist paste-board, a well-defined bundle of N-rays was eventually separated, striking an aluminium prism, one face of which was perpendicular to the direction of the rays. The author states that from the opposite face of the prism, different bundles of N-rays will issue, having undergone a horizontal dispersion, the presence and deviation of which is ascertained by shifting a slit filled with phosphorescent calcium sulphide, according to the well-known Descartes method. The indices of refraction of the rays thus separated are 1·04, 1·19, 1·29, 1·36, 1·40, 1·48, 1·68, 1·85 respectively. These results were checked by measurements made with an aluminium lens.

In order next to determine the wave lengths concerned, the author caused the bundle of rays to strike another screen of moist paste-board, containing a narrow slit so as to isolate a very narrow portion of the bundle. To the movable arm of a goniometer, an aluminium sheet was attached so that its plane was perpendicular to the arm; this metal sheet contained a slit only 1/15 mm. in width, provided with phosphorescent calcium sulphide. By turning the arm, the direction of the bundle of rays may be accurately marked. By placing a grating in front of the slit of the second moist paste-board, and exploring the issuing bundle by turning the arm to which the phosphorescent sulphide is fixed, the presence of a system of diffraction bands quite similar to those observed with light rays is observed, but for these bands being much closer together and having approximately the same reciprocal distance; hence it may be inferred already that N-rays have much shorter wave lengths than light rays. The wave-lengths of the rays found by Blondlot vary from 0·00815 μ for refractive index 1·04, to 0·0176 μ for an index of 1·85.

From the above results, which were checked by further experiments, it is seen that the wave lengths of N-rays are much smaller than those of light rays.

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

7,318. "Improvements in pendant chains for carrying electrical fittings." E. Haslam. March 28th.

7,325. "Improved electrical apparatus for timing the speed of motor-cars or other vehicles over a measured distance." G. Higginbotham. March 28th.

7,327. "Process for the preparation of dynamo brushes." The British Galvanic Metal Packing Co., Ltd. (Galvanischen Metall-Papier-Fabrik Actien-Gesellschaft, Germany.) March 28th. (Complete.)

7,349. "Improvements in electrical communicators." H. Foster. March 28th.

7,418. "An improved hydrometer for use with electric storage batteries." J. Hutton. March 29th.

7,428. "Improvements in apparatus for moving electrically the points on electric tramways and railways." J. P. Tierney and J. Malone. March 29th.

7,429. "Improvements in metallic conduits for electric light cables and the like." L. M. Waterhouse and The Simplex Steel Conduit Co., Ltd. March 29th.

7,497. "Improvements in electric arc lamps." J. J. Rathbone and E. R. Smith. March 29th.

7,505. "Improvements in electric fuses." W. R. Macdonald and G. E. Heyl-Dia. March 29th.

7,526. "Improvements in, or relating to, vehicles propelled by electro engines." H. Pieper. March 30th.

7,527. "Improvements in or relating to electro-engine vehicles." H. Pieper. March 30th.

7,543. "Means for signalling and for controlling the electrification of conductor rails on railways." W. E. Walmsley. March 30th.

7,584. "Improvements in or additions to overhead wires or electrical conductors of electric tramways and the like, and in supports for the same." A. H. Lucas and T. Greenfield. March 30th.

7,586. "Improvements in submarine telegraphy." I. Kitsee. March 30th. (Complete.)

7,610. "Improvements in and relating to electric arc lamps." C. E. Foster, E. R. Grote, and H. V. Ely. March 30th.

7,614. "Improvements in or relating to apparatus for generating and applying electricity on railway and other vehicles." F. J. Beaumont and W. M. Still. March 30th.

7,627. "Improvements relating to electroliers, gas and oil pendants, and the like." E. W. Sanders. March 31st.

7,642. "Improvements in and relating to electric fuses." L. R. Lee. March 31st.

7,660. "Improvements in electric arc lamps." H. C. Levis. (The General Electric Co., United States.) March 31st.

7,661. "Improvements in electric arc lamps." E. A. Carolan. (The General Electric Co., United States.) March 31st.

7,662. "Improvements in electric arc lamps." E. A. Carolan. (The General Electric Co., United States.) March 31st.

7,663. "Improvements in electric arc lamps." E. A. Carolan. (The General Electric Co., United States.) March 31st.

7,676. "Improvement in telephonic communication." J. H. Lee. March 31st.

7,684. "Combined hat-rack and electric light bracket." H. Leitner. March 31st.

7,685. "Improved light diffuser for electric incandescent lights." H. Leitner. March 31st.

7,702. "Improvements in electric toy motors." W. Broad. (Date applied for under Patents Act, 1901, October 5th, 1903, being date of application in United States.) March 31st. (Complete.)

7,710. "Improvements in electric arc lamps." C. E. Foster, E. R. Grote, and M. V. Ely. March 31st.

7,733. "Electric igniting device for explosion engines." The Vereinigte Maschinenfabrik Augsburg und Maschinenbau-Gesellschaft Nurnberg A.G. (Date applied for under Patents Act, 1901, October 19th, 1903, being date of application in Germany.) March 31st. (Complete.)

7,742. "Improvements in electro-mechanical apparatus for automatically operating the shunting points on electric tramways and railways." G. D. A. Parr. April 2nd.

7,748. "Improvements in switches for use in connection with electric lights and the like." G. Chisholm. April 2nd.

7,807. "Improvements in machines for the transformation and generation of electric currents and energy." J. L. La Cour and T. Rich. April 2nd.

7,812. "Improvements in means for supporting and lowering arc lamps or other hanging weights." The Improved Electric Glow Lamp Co., Ltd., and N. Watsham. April 2nd.